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37.

ON THE

MOST ECONOMICAL AND PROFITABLE METHOD

OF

GROWING AND CONSUMING ROOT CROPS.

BY W. C. SPOONER,

OF ELING, SOUTHAMPTON.

AUTHOR OF THE ROYAL AGRICULTURAL SOCIETY'S PRIZE ESSAYS,
" ON SUPERPHOSPHATE OF LIME," AND " ON THE MANAGEMENT OF FARM-HORSES."

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ROOT CROPS.

The successful cultivation of root crops is the one great feature which characterizes British agriculture, and favourably distinguishes it from continental farming. When largely, systematically, and successfully carried out, it compensates in great measure for those other disadvantages under which farming labours in our climate. It furnishes ample employment for human labour, and it insures the cleanliness of the land; it indirectly supplies a vast amount of human food and clothing; and it does this economically and advantageously by catching and assimilating from the atmosphere a vast amount of valuable nourishment, which is so inexpensive that it costs nothing more than the expense of the means of collecting. Such reasons are sufficient to justify the primary importance attached to the successful cultivation of root crops.

Let us therefore at once proceed to consider, in accordance with the programme of the Council—

1*st.* *The kind of land on which it is profitable to grow roots, with especial reference to any instances of successful management on heavy land.*

A good turnip soil is an expression so well understood and so generally appreciated, that it appears in every auctioneer's advertisement where there is occasion to describe an estate having the slightest pretension to such a desirable character. Strictly speaking, however, such designation should be confined to land with a porous subsoil, that ploughs readily with two horses, that dries quickly after rain, and yet does not burn in dry weather. Such are the mechanical conditions the turnip requires for its perfection, and a moment's reflection on the character of this root suggests at once a reason why these physical properties are so requisite. The turnip is a plant of quick growth, and in the course of a few months swells from a puny rootlet to a bulb of many pounds weight. In reaching this size it of course displaces a quantity of earth equal to the space of ground afterwards occupied by the root, and the resistance the bulb meets with in its outward development materially affects the size of the root; not only so, but it also prevents, or assists in preventing, the feeding of the root with many of the elements necessary for its support, and more particularly with that portion of carbonic acid which is furnished through the medium of the soil. Thus we find that when the seed is put in unkindly—when the soil is clung, as it is termed, by a succession of rain, the crop never reaches any size. It is of far less consequence if the land should be hard beneath, provided it is fine on the surface, and the reason is self-evident, for the former is only occupied and pierced by the small rootlet, whilst the latter is the habitation of the bulb itself.*

These observations tend to show the importance of a free-working soil for the perfection of the turnip plant, but soils having equal mechanical requisites may be found composed of various materials, and combined in very different proportions. Thus one turnip soil may contain 80 per cent. of silicious matter in the form of fine sand and gravel, and another 60 per cent. of calcareous matter in the form of chalk, and yet both soils may be equally porous, and both well adapted for the growth of turnips. We may, therefore, lay it down as an ascertained fact that, if a soil does not contain a considerable per centage of chalk, it should contain a very large proportion of silicious matter, and although a small amount of clay is desirable, a large quantity is injurious by causing too great stiffness of soil. Another material, however, is requisite to constitute a first-rate turnip soil, which is that mixture of various substances understood under the term loam. This loam consists for the most part of carbonaceous matters with various peculiar acids, such as humic and ulmic acids, intimately combined; and when we know that this loam not only possesses the requisite physical characteristics, namely, porosity and retentiveness of moisture, but in addition the various chemical elements which supply food for the growing plant, we cannot be surprised to find that the heaviest turnip crops are to be found on free-working loamy soils.

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* It may perhaps be urged, in opposition to this theory, that the bulb of the turnip is as much above as below the surface of the ground. This is true; but at the same time it must be borne in mind, that as each kind of root has its particular shape, if its free development below the surface be prevented, the swelling above will also be greatly retarded. If this were not the case, the shape of the roots would be continually changing, according to the character of the soil. Again, if a root meets with a large stone, does it displace this stone? No; on the contrary it accommodates its growth to it, and often becomes misshapen in consequence. It may also be urged that carrots grow much more above ground on stiff land than on a light sandy soil, which the roots find no difficulty in penetrating; and however good the produce per acre may be on strong land, the individual roots never reach the extraordinary size often observed on a light deep soil.

Although our observations are principally directed to turnips, yet we must bear in mind that the various crops understood under the term roots are also comprehended in our inquiry—such more particularly as mangold wurzel and carrots.

Swedes will flourish on a stronger soil than is found desirable for common turnips, which is consistent with the fact that their growth is slower and they are firmer in texture. Mangold-wurzel delights in a deep loamy soil, but admits of a larger proportion of clay than swedes, which is explained by the fact that the greater portion of this root grows above ground. Much of the land in Somersetshire and Devonshire, particularly that near Taunton, is well adapted for this crop. Mangold-wurzel can withstand the effects of drought much better than turnips; indeed much wet is by no means conducive to its success. Thus it is that the south, and more particularly the south-east, of England is more favourable to the growth of this root than either Scotland or the west of England.

Carrots succeed best in a deep sandy soil, which offers no resistance to the downward progress of the root, but permits it to revel in the subsoil without any obstruction or interruption to its course. They abhor the presence of large stones, cannot exist on the surface of rocks, and become stunted and deformed if raised on chalk. Although clay is not the soil most suited for them, yet very good crops have been raised, particularly of the Belgian carrot, on stiff loams with a clay subsoil. Indeed this is an advantage which belongs to this variety; not only can a much greater crop be grown of the Belgian as compared with the red carrot, but it can be grown with success on a much stronger soil. It has even been suggested that on chalky soils, by throwing the surface soil into ridges and growing carrots on the top, sufficient depth will be attained for their growth. Many instances of the successful management of roots on heavy land have come under the writer's attention, although these instances are principally confined to swedes. As an instance may be given the following account of Mr. Blundell, of Bursledon, near Southampton, to the accuracy of whose statement the writer can testify from his own personal knowledge. Mr. Blundell, in reply to the inquiry addressed to him, thus writes:—

"As an instance of the successful management of heavy land, I may instance my own management of forward ewes and lambs on land not usually appropriated to the purpose, for although some part of my farm is comparatively loamy, yet the heaviest land feeds very badly in most winters, and I am satisfied would be rejected for the purpose by many practical men; yet after 20 years of successful management of my stock upon this soil, where in some seasons we have fed our sheep for months in succession when the whole field has been a mass of mud, I can safely say that it is more from apprehension than any well founded objection that it is not more generally practised; but this system depends entirely upon trough-feeding for its advantage, because if we attempted to feed the turnips on the land half the crop would be trodden under and wasted. I would draw this conclusion from what is here related, that as it has been done for many years with a ewe flock, requiring the greatest care and nicety in management, it might be done with wether sheep, tegs, &c., much more easily."

This farm, although it is certainly heavy, has the advantage of being somewhat hilly, and in consequence frees itself more readily from undue moisture. On flat land of a tenacious character sheep feeding should certainly be avoided during the depth of winter.*

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* The following additional particulars have been supplied, in reply to some questions addressed to the writer:—

Mr. Blundell's farm has not been what is called thorough drained, yet it has been drained according to the best plan of the period at which it was effected (eighteen to twenty years ago); and for the most part it has been completely effective, particularly where springs have been taken off. Other portions of the farm on which thorough draining is suitable, but which have been drained across the fall, are not so completely dry; neither does the land there carry sheep so well in the winter months, nor produce such good crops of corn and roots, as a small part of the farm which has been more recently treated upon the improved principle of laying the drains in the furrows in the same direction as the fall of the land.

For a period of fifteen years, Mr. Blundell's flock of ewes and lambs received no kind of food besides roots and hay. The turnips, however, were invariably cut and given in troughs, the hay, of first quality, being put in cages in the ordinary state, and not cut into chaff. By feeding in this manner during the above-named period, excellent stock has been made out, both ewes and lambs, as well as wether sheep; and Mr. Blundell has, in many instances, taken premiums in the fat stock markets for these sheep, when exhibited in competition with the best corn and cake-fed stock. During the last seven years, however, since the *foot-lameness* has been so prevalent amongst sheep, he has found it advisable to assist his ewes and lambs by feeding with cake and corn in addition to roots and hay.

Although it is a common practice to take sheep out of a field of turnips during wet weather, yet Mr. Blundell objects to it for the following reasons:—It alters their habits of feeding, more particularly in the case of ewes and lambs, making them restless and dissatisfied; and it is with difficulty the lambs can be induced to pass through the gate to take their food separate from the ewes, after their habits have been disturbed by occasional removal from the field. The ewes likewise, after removal to drier ground, on their return to the dirt, can hardly be induced to wade through it on their approach to the feeding troughs; and when there is a long continuance of wet weather, the land remaining dirty for several months in succession, no system of change or removal can be fully carried out except at considerable cost. Although it is known to every practical farmer that it is foreign to the nature of sheep to be kept thus, yet those who have not seen the system carried out, would scarcely believe how the animals become accustomed to the mud and dirt, and how well they will thrive whilst kept in this comparatively unnatural manner, if they are fed with regularity and care.

2. *The Time, Mode, and Cost of Preparing Land for Roots, distinguishing between Light and Heavy Lands.*

Our observations under this head must be principally directed to light lands and to the turnip crop. The course of cropping usually observed on such lands is that commonly understood as the four-course, or Norfolk system, "wheat, turnips, barley, and seeds," subject however to various exceptions, such as the continuance of the same land for two years under seeds, thereby causing a five-course system; and on chalky soils the interpolation or laying down of a certain portion to sainfoin for four, six, or eight years. Again, wheat frequently succeeds turnips instead of barley on some portion of the turnip land, and early turnips are often sown after a crop of Swedes, fed off at a later period than would be favourable for barley sowing. However, notwithstanding these exceptions to the usual course of cropping, turnips in the majority of instances succeed wheat; in the stubble of which, the first preparation for this important crop is to commence. The objects to be accomplished are twofold, viz., to clean the ground, and to render it fine and friable. To effect these purposes in the cheapest and most effectual manner is all that is requisite. There used to be a sort of unmeaning or superstitious idea that turnip land could not be ploughed too often, and there was some peculiar virtue supposed to accompany five ploughings, as if the benefit belonged to the operation itself, and not to the effect these ploughings should accomplish. This idea, however, is altogether erroneous, for one of the best crops of Swedes we have seen was raised after one ploughing only; and, although the unclean state in which the wheat stubble is frequently left forbids this plan to be generally adopted, yet it may be laid down as a rule that so much ploughing is required as will permit the land to be effectually cleaned and *no more*, and it is seldom that more than three ploughings are requisite. Two will not suit, as this brings the surface that has been ploughed under again to the top before it has been decomposed; but if the land is in a clean state, one good ploughing only is requisite. The land ploughed up before Christmas and exposed to the winter's frost offers a finer and better surface for the deposition of seed than can be gained by subsequent ploughings, and the scarifier and the harrows will accomplish all that we may further require. So likewise if the land should not be in this clean state, yet if the autumn is dry and favourable, and the operations on the farm sufficiently forward to permit the horse-power to be devoted to the task, there is no better plan than to clean the land in the autumn, and, this being done, to leave the surface to be acted on by the weather and the frost, and thus fitted for the reception of the seed in the spring. This cleaning process is best commenced by paring the stubbles, either by means of one of the many good scarifiers that have been of late years introduced, or by a paring plough, or even by the common plough, with a share of twice the usual width attached and the turn-furrow either removed or not, which plan is very suitable for heavy land and high-backed ridges. The surface thus pared, the harrows will sufficiently shake out the earth, and the rubbish left may either be burnt or carried off the land to bed up pigsties or ox-pens, or to make a compost heap for pasture, where the seeds of the weeds will not be injurious. After the surface has thus been cleaned, a little time should be given, so that the seeds of various weeds scattered on the land by the previous operations may have time to vegetate. In the course of two or three weeks this will probably be the case, and then the land should be ploughed or ridged up for the winter, and this ploughing should be the deepest the land ever receives. A little fresh soil brought to the surface is often highly conducive to the growth of turnips, but of course this does not apply to cases where the subsoil is unfavourable, nor where it consists of either clay or chalk.

When the land is full of couch, and the season will admit, the autumnal cleaning process may be carried to a greater extent, by half-ploughing or raftering the land, then using the scarifier across, which breaks up the surface and prepares it for the drags and harrows. On heavy land, however, the same effect is often better accomplished by using a very broad share to the plough, and turning over only half the slice thus cut off. These operations, however, materially depend for their success on the character of the weather. The autumn of 1851 was particularly favourable for such operations, while the present season is altogether unsuited for any attempt of the kind. If carrots or mangold-wurzel are intended to be cultivated, the autumnal operations we have spoken of are more particularly needed, indeed it would be folly to attempt to produce these roots unless the land is cleaned previous to Christmas, as, on account of the earlier period at which these crops require to be sown, there is not sufficient time in the spring.

Although on all soils the economy of dispensing with ploughing must be felt, yet a peculiar advantage beyond this saving of expense is experienced upon heavy and unkind land; because upon light soils, however much the land is ploughed, you can always obtain a fine tilth, whilst with heavy land, if you once turn over the soil and bury the fine stale surface which has been produced by the alternate action of frost and rain during the winter months, it is doubtful whether you will get the land so fine again, and, if it be rendered so, it is by forced means, seldom producing a kind bed for the small seeds of the turnip. Although, under the above plan of once ploughing, the land is kept firm at the bottom, yet the tillage can be deepened as much as may be desirable by the use of the scarifier, still retaining the weather-beaten surface, so favourable to the early growth of the turnip plant. Mr. Blundell, to whose practice allusion has been made, has now growing an excellent crop of carrots, after once ploughing, on land which four years since produced a good crop of Swedes also from once ploughing only.

To show the saving that may often be effected (when the land is free from couch), the following calculation of expenses on heavy land actually incurred by the two systems is given. In each case Italian rye-grass had been sown amongst the wheat in the preceding March, and afforded useful feed for sheep from August to December :—

No. 1. Under the usual System.

	£.	*s.*	*d.*
In December, one deep ploughing, at per acre	0	12	0
In February, two draggings .	0	1	6
Two harrowings	0	1	0
One rolling	0	0	9
In March, one ploughing . .	0	10	0
Four draggings	0	3	0
Four harrowings	0	2	0
Two rollings	0	1	6
In May, one ploughing . .	0	8	0
Two draggings	0	1	6
Four harrowings. . . .	0	2	0
Two rollings	0	1	6
	£2	4	9

No. 2. Under the improved System.

	£.	*s.*	*d.*
In December, one deep ploughing, at per acre	0	12	0
In April, two draggings . .	0	1	6
Two harrowings	0	1	0
One rolling	0	0	9
In May, one scarifying . .	0	5	0
Two harrowings	0	1	0
One rolling	0	0	9
	£1	2	0

The result of the crop was in favour of No. 2. The propriety of sowing Italian rye-grass for autumn sheep-feed depends entirely on the fact as to whether this feed is greatly needed at this period of the year, which in some farms with little pasture land is the case. In such instance autumn cleaning must be dispensed with, and indeed it ought not to be required if Italian rye-grass is sown.

The period for commencing operations on the turnip land in the spring must be regulated by the character of the season and the other requirements of the farm: accordingly, it is seldom they are begun until the Lent crops are sown, and then a course of wet weather will often cause a further delay, varying however materially according to the character of the land; for on some light, thin, porous soils the plough can enter the ground with impunity, and even advantage, on the cessation of rain for one or two days, whilst on other still favourable soils we must wait for the drying of the land, evidenced by the altered colour of the surface, before proceedings can be commenced. These must, of course, depend on the condition of the soil as to cleanliness. If infested with couch which could not be removed in the autumn, it will often be necessary to run the furrow back, as it is termed, that is, to bring up again the surface that was buried by the previous ploughing; shortly after which the land may be cut across, either with the plough or the cultivator, the object of which is to break up the furrow, and then by a series of rollings, scarifyings, and harrowings to accomplish two purposes at the same time, to bring the couch-grass and other weeds to the surface, and to reduce the soil to a fine tilth. It should be observed, that some good farmers object very much to the cutting the land across, as it is apt to form large clods. It is in the course of these operations that Croskill's or Cambridge's clod-crushers can often be made to render valuable assistance, effecting by their weight and their power of penetration that reduction of the sun-baked clods which can otherwise be only accomplished by a vast number of rollings and draggings, or by a shower of rain, through waiting for which we may be subjected to a great loss of time. Having now by means of horse and manual labour and the aid of good implements brought the land to a fine surface, it will be very desirable, if the season is not too far advanced, to allow the seeds of annual weeds to vegetate, in order that they may be destroyed by the last ploughing or ridging up. This being done, the seed should be deposited as soon as possible. There is so much more probability of the turnip-seed vegetating kindly on earth that is fresh ploughed than on that which is in a state of fallow, that it should, if possible, be drilled the same day as it is ploughed. The scarifier is a more useful implement on light than heavy land. Light land, indeed, should be ploughed as little as possible if it is clean, so that the cultivation may be completed without loss of moisture to the soil; this may be considered one of the most important points in the raising of roots in the southern and western counties.

It may be well here to refer to the best period of sowing the different roots we have noticed. For carrots and mangold-wurzel the last week in April to the third week in May offers an appropriate period, commencing with carrots, and finishing with mangold. With regard to Swedes, although there has been a great feeling in favour of some particular period, viz., about the middle of June, as being most advantageous, yet the experience of late years has convinced us that it is best to modify the period according to the season; and when the land is fine and the weather favourable, we should not hesitate to put in a certain portion of the Swede crop during the month of May. Although there is somewhat greater danger from the fly, yet there is a more extended opportunity for a second sowing, should it be required. And it may so happen in very many cases (as it did in 1852), that, if we miss the most favourable opportunity, a month's bad weather may follow, and put off the period of sowing so late as to destroy our chance of obtaining a first-rate crop. Swedes may be sown from the middle of May to the second week in July in the south and west of England, whilst other turnips may continue to be grown to the end of July.

3. *In what cases is it profitable to Grow a Spring Crop of Green Food before Roots in the same Year?*

Two very opposite opinions are held on this subject; some assert that turnips grow so unkindly after a green crop that they can rarely, if ever, succeed in obtaining them; others, finding that by the aid of artificial manures turnips, and even Swedes, can be obtained with little difficulty, resolve on introducing the plan throughout their whole course, and sowing no roots except after a crop of vetches or grass. The consequence has been, in several instances that have come under the writer's notice, that some gentlemen who had previously been in the habit of raising the heaviest crops of Swedes have been obliged, after the introduction of the innovation, to be contented with the second rank, and, although they still succeeded in raising first-rate crops of mangold after a fallow, they altogether lost their pre-eminence with regard to Swedes. The best course will probably be found to lie between the two extremes, and to put in the turnips that are intended to be fed off before wheat, and also a portion of the Swedes, after a fallow, and the remainder of the turnip crop, amounting probably to one-half, after a green crop. By such means the labour on the farm will be properly divided and apportioned, and any part of the land that may be in a foul state will have an opportunity of being cleaned. A fair portion of the roots will be planted in good and sufficient time, and when this is completed some of the vetches or other green crops will have been cleared off by the sheep. It has been a common subject of complaint that, although there is ample time to clean, plough, and dress the land, yet that turnips do not grow kindly after vetches. We hesitate not to assert that, by the aid of proper manures, there is no difficulty whatever in getting a crop, and frequently a very good one, after vetches or any grass that can be cleaned away in sufficient time; and the inducement is now so great on all sheep-breeding farms in the South of England (to which our observations are more particularly directed) to keep as large a flock as possible, that a farmer in such locality would be extremely unwise if he were to neglect this favourable opportunity of increasing the resources of his farm. A portion of the green crops thus produced will, no doubt, be cut for the farm-horses and other stock, but the greater part will be fed off by sheep. As it is in every respect a leading object to obtain green food as early as possible in the spring, when the Swedes are nearly consumed, and a good portion of the pastures shut up for hay, it will be judicious to sow rye over a portion of the land, as, although the feed may not be so abundant, it yet comes in earlier than anything else. By sowing rye early it may be fit for feeding by the middle of May, and turnips always grow kindly afterwards. Although on loamy soils *trifolium incarnatum* gives a large produce, yet vetches form the bulk of the feed, and a portion should be sown early, and an early sort sown, so as to follow rye at the end of May and beginning of June. By thus having a succession of sowings, with fortnightly or weekly intervals, from the beginning of September to the end of October, a supply of green food will be kept up from the middle of May to the middle of July, and afterwards, if required, by means of spring tares.

In feeding off this green food the sheep will of course be folded, a fresh fold* being given daily, and the vetches mown and given to the sheep in cribs. As soon as a sufficient quantity of land is cleared the plough should be put in and the turnips sown as soon as possible. It is customary, and by no means a bad practice, to sow early turnips after late fed swedes. The advantages of the practice are, that a portion of the swede crop can be retained and fed on the land during the month of May, there being no necessity to remove them earlier for the sake of putting in barley; and, as the swedes thus fed off will leave the land in good condition, a small quantity of manure will suffice for the turnips; and these again being fed off, the land will be in high condition for wheat. If it be objected that this practice throws the land out of rotation, and diminishes the extent of the barley crop, it may be answered that this may be obviated by letting barley follow the wheat sown after two crops of roots, which will bring the course round again.

Another very good practice is to sow mangold-wurzel, or white carrots, on suitable soils after late fed swedes. The land will be in excellent condition for the former crop, requiring but little manure, and these roots can thus be raised at a small expense, as little cleaning will be required. Turnips grown after a green crop are less subject to the attack of the fly and the wireworm than those sown after a fallow.

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* For this purpose a few of the slanting iron hurdles, made by Hill and Co., of Brierley, in Staffordshire, will be convenient, as they can be set without making any holes, as chairs may be moved from one side of a room to the other; and the sheep put their heads through them easily. They cost about 4s. 6*d*. each.—T.D.A.

4. *The Quantities, Sorts, Time, and Mode of applying Manure to Root-Crops with especial regard to Economy.*

This forms by far the most important division of our subject, as it points in the direction of inquiries from which much valuable information has already been elicited, and which information requires but to be more generally diffused and acted on in order to increase materially the products of English agriculture; for, although there are a few special spots abounding probably with a large per-centage of phosphate of lime, where turnips can be raised without manure, and where bones, and manure manufactured from bones, have but little effect, yet this is altogether an exception to the general rule; and in dealing with our subject we may be allowed to adhere to the rule and not to the exception. On the majority of soils, and particularly on the light chalky lands of the south of England, crushed bones have been found to answer remarkably well in the production of the turnip crop; and, although it is only within a very recent date that it has been well understood to what portion of the bone the great benefit experienced by the turnip crop is due, yet successful practice had preceded the explanations of science, and covered our hill-tops with verdure throughout the winter months, where nothing used to be seen but a naked fallow. It would be somewhat difficult, and indeed our limits would scarcely permit us to trace accurately the history of the introduction of bones; suffice it to say that they were generally used in the north of England, and particularly in Lincolnshire, some years before they became well known in the south; indeed the rapid progress made in agricultural management in the localities we have mentioned may be ascribed very much to the employment of bones. The custom, however, when first introduced, was to apply a considerably larger quantity per acre than after-practice proved to be necessary or advantageous; and thus, when the course came round again for turnips, it was found that the second application of bones was not so striking in its effects as the first, although all the crops in the interval had been greatly benefited. There can be no question as to the large increase of sheep-feed occasioned by the introduction of bones, which, being a portable manure, could be used on spots either totally inaccessible to farm-yard manure, or where the expense of its carriage would forbid its employment.*

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* As an instance of the long continued effects of a liberal application of bones, we may instance the following fact:—Some twenty years since, Mr. T——, of B——, drilled a quantity of bones for a turnip crop on a hilly piece of ground. It was intended to apply about sixteen bushels per acre, but the drill at that time not being so perfect as at present, every alternate course received double the quantity of bones that were distributed when the drill returned down the

The fact, however, is that there is no occasion whatever for carrying dung to the tops of high hills; all that is required is to raise good root crops, and to feed them off on the land with the assistance of corn or cake, and we need not fear for the result. The dung may be more profitably employed nearer the homestead, and where the carriage is less expensive. If we wish to add to the staple of the soil on these high and barren spots, we can do so by growing green crops, such as mustard, and ploughing them in.

Within the last 8 or 10 years the production of root crops has received a vast increase from the introduction of guano into this country, and still more by the contemporaneous preparation of superphosphate of lime.

It is well known and generally acknowledged that it is to a suggestion of Liebig that the merit of this discovery is due, although there are many others who may equally lay claim to having conquered, by their experiments and practices, the practical difficulties attending its first employment, and thus introduced it generally into public notice. Amongst them is the present writer, who has thus, from its very first employment, had the best opportunity of assisting as well as watching the development of facts which have greatly conduced to satisfy the increasing demand for animal food, and to mitigate the difficulties under which the cultivator of the soil has laboured.

There can be no question whatever that the use of superphosphate of lime has very considerably increased the production of roots, and this has enabled a much larger quantity of sheep to be both bred and fatted off. Many cases have come before the writer's attention, where it was some years since the custom to pay a considerable sum annually for the keep of the lambs or hogs through the first winter,—now the same amount being expended principally in superphosphate of lime has enabled these breeders to keep their young sheep at home, thus adding materially to the corn-producing resources of the farm.

In returning however to our question, and in considering it with especial regard to economy, we have first to dispose of a very important query, which meets us at the very threshold, viz., Is it best to reserve the farm-yard manure for roots, or to employ it principally for the wheat crop?

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hill. The effect of this was visible in the turnip crop. The land was laid down to sainfoin with the barley which succeeded the turnips, and it so remained for nine years, when the land was breast-ploughed and burnt, and turnip-seed drilled in with the ashes. On this occasion the drill passed in a different direction, viz. by the side of the hill. Soon after the plant came up, the effect of the former double application of bones was very visible, and conspicuous for several miles distant; appearing, indeed, as if the crop had been again drilled up and down the hill, so superior were the turnips on the land which twelve years before had received a double quantity.

Some years since it was very properly considered that the best system of manuring was to reserve all the dung for the turnip crop, and to apply none to wheat. This was a very good practice when dung was the only manure, inasmuch as though we may raise a very moderate crop of wheat without manure year after year, we can scarcely raise any turnips without it after the first year. This is owing to the fact which was then unknown, but is now well understood, viz., that turnips require an immediate and copious supply of phosphate of lime, and that in as soluble a state as possible; so that, in order to supply a sufficient quantity of phosphate of lime, about 1⅓ cwt. being consumed by the crop, it was necessary to furnish some twelve to sixteen tons of dung in as black and rotten a state as possible, in order that the phosphates might come quickly into action. It was further necessary, in order to secure the decomposition of the dung, that it should be frequently turned so as to promote its fermentation. By this process a considerable quantity of ammonia (at least half of this valuable constituent) was dissipated and lost. This, however, was the only method of raising a good crop of roots, which was most essential in order to raise more dung. With the general introduction of concentrated manures, a great modification and alteration in the practice of manuring is now gradually introducing itself, viz., to apply the dung to the wheat and the concentrated manures to the turnip crop. The advantages of this altered system may thus be summed up:—

1st. We avoid the labour and expense of frequently turning the dung, which may either remain in the yard well trodden down, or in the field securely covered up with earth.

2nd. We save by so doing a considerable quantity of ammonia, which would be otherwise dissipated by great fermentation.

3rd. We avoid the labour and inconvenience of drawing out the dung at a period when there is so little time to spare, and when to lose the season is often to lose the crop.

4th. We reserve the dung for that crop which requires nearly *all* its constituents, instead of expending it merely to furnish one or two.

5th. By thus furnishing only what the turnip principally requires, and that in a very soluble form, we are enabled to draw from the atmosphere the principal portion of its other constituents; and we find that the amount of produce raised by concentrated manures, over and above the natural product of the soil without manure, is considerably greater, at the same expense, with turnips than with wheat.

We might here observe that the dung, when it is used for the wheat, has plenty of time to rot before its carbon or vegetable matter is wanted for the turnip crop. For these reasons we hold it to be the best practice to apply, what dung there may be on the farm, to the wheat crop.

The principle on which the successful application of superphosphate of lime rests is, that it supplies the peculiar nourishment required by the young plant in a perfectly soluble state, so that it may be dissolved in water and drank and digested by the tender root, By thus having a large and ready supply of this nutritious food the leaves of the plant are rapidly and freely developed, and are thus enabled to extract a very considerable portion of nourishment from the atmosphere. Now the food in which the young plant so freely delights is phosphate of lime, and the element which the atmosphere so largely furnishes to it is carbon, in the form of carbonic acid. It is true that this phosphate of lime is not found in the turnip crop in a larger proportion than many other elements, the effects of which, if supplied as manure, would not be so striking, but yet it is the fact that it is the very essential food which the tender plant requires; no sooner are the rootlets sent off from the plant than an abundance of necessary food is thus placed within its reach. A given quantity of rain can dissolve ten times the quantity of phosphate of lime in the state of superphosphate than it can in the ordinary form of neutral phosphate, as it exists in raw bones—thus a young plant may riot luxuriously when furnished with the former, whilst a neighbouring plant manured with the latter may languish for want of rain. So much has lately been written on the subject of superphosphate of lime, that few of our readers require to be told that it consists, roughly speaking, of two portions of phosphoric acid united with one of lime, and in this state it is soluble in water, whilst neutral phosphate, as in bones, contains about equal parts of phosphoric acid and of lime, and is very sparingly soluble, requiring indeed the presence of another acid to render it so. Thus it is that we find in porous soils, affording a free access and supply of carbonic acid, that bones act much more readily than on retentive clay soils. The superphosphate is not brought into its soluble state by adding phosphoric acid, but by abstracting from the phosphate of lime one-half its lime. This is effected by the action of sulphuric acid, for which lime has a stronger affinity.

It has now been satisfactorily shown that although the food of plants consists of very many materials, yet there are two which are beyond all comparison more important than the rest, that is ammonia and phosphoric acid—the former the essential manure for corn, and the latter that for the turnip crop. The phosphate of lime is the earthy material of bones, constituting about one-half their substance, consequently in the process of rearing stock a considerable quantity of phosphate of lime is carried from the land by the animals, far greater indeed than any other inorganic material; and although the turnip contains potash and soda, and other elements as well as phosphate of lime, yet nearly the whole of these matters are left behind in the dung. Besides which these earths are much more abundant in the soil than phosphate of lime. This sufficiently explains the fact, that although there is no objection to apply potash and soda when very cheaply procured, or when in previous combination with other manuring substances, yet it is altogether unprofitable and unnecessary to purchase these materials at any such prices as they are usually to be met with in the market. Although the application of nitrogen, or rather its compound ammonia, to the soil as a direct preparation for turnips is neither so essential nor so marked in its results as the application of superphosphate of lime, yet it is a mistake to suppose that it is not required. Not only is the crop larger and the shaws more vigorous, but the roots are also more nutritious, abounding more with the material which furnishes flesh to the animal.

To bring our observations under the present head to a practical conclusion we must address ourselves directly to the question, What is the best manure for the turnip crop on the majority of soils? We have spoken of the properties and advantages of superphosphate of lime, and pointed out the advantage it possesses over every other manure in affording a large supply of soluble food. It should therefore invariably form a portion of the manure applied for the turnip crop, but it must be borne in mind that the manure is not all required at once, and therefore there is no occasion to supply the whole in a very soluble form, but rather an advantage in supplying some portions in a form which comes more slowly into action. Thus perfectly consistent with sound theory is that which we find most successful in practice, viz., that some portion of the manure should be furnished in the form of superphosphate, and some in the form of plain phosphate, joined with a moderate amount of ammonia, which is just what bone-dust supplies. We have so frequently found this system successful, that we can with confidence recommend the following mixtures as highly suitable for a crop of swedes:—

Superphosphate of lime .	2 cwt.
Bone-dust . . .	8 bushels,

to be mixed and drilled with ashes; or we might vary it thus:—

Superphosphate of lime .	2 cwt.
Bone-dust . . .	4 bushels.
Peruvian guano . .	1 cwt.

The latter might more advantageously be sown broad-cast, and the two former drilled with ashes. By sowing the guano broadcast we do not endanger the seed, and we supply nutriment for the filaments given off laterally from the roots.

There are many varieties of guano much richer in the phosphates than Peruvian guano, but poorer in ammonia, and these suit admirably for turnips, particularly when combined with superphosphate of lime. Such are the Saldanha Bay, the Patagonian, the Chilian, and other varieties, more particularly the Bolivian, which is the best. Although the analyses of some of these guanos very much resemble that of bones, both with reference to the proportions of ammonia and the phosphates likewise, yet their action is greater and more immediate, having been passed through the bodies of birds and digested. Thus we have found the following succeed admirably:—

Superphosphate of lime	2 cwt.
South American guano, containing 50 to 60 per cent. of phosphate of lime . .	2 cwt.

and this can either be drilled with ashes, or by means of the water drill.

In many cases good crops have been raised by using only half the above quantities per acre, and it is certainly true that excellent effects can sometimes be obtained by using a very small amount of manure, yet we hold it as very bad economy to be so sparing in the use of artificial fertilizers. If the additional quantity will but produce extra roots to pay for the increased quantity of manure, it must answer well to use it, for the land will be left in a better state. Whether we apply much or little it is quite impossible to bring all the manure into action for one crop, but the more we use within certain limits the more will be taken up by the plants, and the more will also be left behind for the use of after crops; nothing, in fact, will be lost or wasted. If, however, circumstances or necessity forbid our going to so much expense as that we have advised (about 34*s.* per acre); then, if we are so limited, the two cwt. of superphosphate should still be applied, and the remainder of the manure dispensed with, for we are convinced that two cwt. of superphosphate can be applied on most soils in the South of England, with greater advantage than any other manure. If, after this outlay of 14*s.* per acre, anything remains, we may with advantage add as much as can be afforded of bone-dust or guano.

Many people have a great prejudice in favour of using half-inch or coarse bones, but we have found that the advantages of using them crushed fine are very considerable. The surfaces of the bones being greatly multiplied, a much greater amount can be brought into action for the first crop;—quite sufficient, indeed, to counterbalance the little increase of expense paid for extra pulverization. It may be replied, that it is much easier to adulterate finely crushed bones than coarse, and that by purchasing the latter we avoid this risk. Our answer is, deal only with respectable men of good character, and do not tempt their honesty by giving the preference to a knave, who would sell you a similar article in appearance at a fraction lower in price. Rely upon it, if you give your confidence to an honourable man you will not be deceived, but if you view every one with suspicion and distrust, and treat the honest man and the rogue alike, you will probably be taken in. Much has been said and written on the subject of the adulteration of manures, and it is unquestionably the fact that the practice has been carried on to a very large extent; but for this, although farmers have been the sufferers, they have themselves to blame to a very considerable extent. Sometimes a farmer takes a sample of corn to market, offers it to one or two parties, but cannot get his price; at length, however, he succeeds as he fancies with a stranger; he gets his price, it is true, but on condition that he takes it out in manure. The dealer, who can get no profit out of the corn, takes care to get a liberal one out of the manure, not, however, by obtaining a higher price than it is usually sold for, but by selling an inferior article.

To return, however, from the digression into which we have been led, it may be asked, do we recommend the manures we have stated alike for all soils?—Not so, but, with some little exception, for nine cases out of ten in the south of England; for it is found that superphosphate of lime will act very favourably on calcareous soils, on which bones also are successful, and it will also succeed well on stiff clay soils in which bones will scarcely act. There are, however, certain sandy soils containing a good per centage of phosphate of lime, which can grow very good roots without manure, and on which bones do not appear to be of service, and superphosphate is also not very satisfactory in its effects. On such soils we would recommend Peruvian guano, applied broad-cast with a very small quantity of superphosphate, about 1 cwt. per acre, just to start the plant, or instead of a portion of the guano the dried flesh which we import from South America. In a previous division of our subject we have stated that turnips may be readily raised after vetches. In considering the manure that should be applied, we have to state that superphosphate is here also particularly successful, and its peculiar property of forcing the plant in its early stage is of more advantage late in the season than earlier. It may be and frequently is stated that if the previous green crop is fed off by sheep, the dressing left behind ought to be sufficient for the turnip crop. We have, however, known several instances where the vetches have been cut for horses, and the land manured with only 1½ cwt. of superphosphate, and on the adjoining land, where the vetches have been fed off and the turnips put in with ashes, although the sheep dressing has been valued at 40s., and the superphosphate cost only 10s., the crop from the latter has at least doubled that of the former. This clearly shows that superphosphate is the manure in which the turnip mostly delights, and that it is bad economy to dispense with it, whether the vetches are fed off with sheep or otherwise, for the sheep dressing will not be lost, but in addition to its increasing the root crop its effects will also be strikingly visible in the after corn and seeds, and will yield an ample return. If the vetches have been carried off the land it will be advisable to use not less than 2½ cwt. of superphosphate, but if they have been fed off then 1 cwt. will be sufficient.

On farms where a large quantity of dung is made (more than sufficient for the wheat crop) it may be advisable to apply a portion to the root crop, and this should be done, if possible, in the autumn, ploughing it in, and letting it combine with the soil. If dung is applied to the root crops, and mangold-wurzel is grown on the farm, it is better that this crop should receive it in preference to swedes, as mangold requires a larger amount of ammoniacal manure than turnips. We cannot therefore do better than plough in the dung in the autumn for this crop, and in the spring apply with the seed about 2 cwt. of superphosphate, and in addition about 1 cwt. of Peruvian guano, broad-cast, with 2 cwt. of salt per acre. If no dung is used, then 3 cwt. of Peruvian guano should be applied instead of 1, or a few cwt. of the dried flesh manure or bones instead of a portion of the guano.

The same observations apply also to carrots. It is common to say that this crop does not require manure, merely because good crops have sometimes been grown on land in high condition, without any immediate application of it; we have, however, found that there has been a very marked difference in this crop where manure has been used and where it has not. It should, however, in no case receive an immediate application of dung, as this causes the root to fork or branch out laterally, and not to descend. The same manure we have advised for mangold we have also found succeed extremely well for carrots.

The dried-flesh manure, which we have spoken of as forming a very useful preparation for mangold, contains about 7 or 8 per cent. of ammonia, or rather nitrogen equal to it, but it requires to be decomposed in the soil before it furnishes food for plants.

5th. *The best Mode of Cleaning the Crop, the Distance between the Plants, and the most useful Implements for Sowing and Cleaning.*

The best mode of cleaning the crop is by means of the united assistance of horse and manual labour—by using the horse-hoe between the drills, and thinning out by the hand-hoe. The distance between the rows, therefore, must be in some measure regulated by the space required for using the horse-hoe conveniently. On dry and light land Garrett's horse-hoe, which takes a number of rows at once, is a very excellent implement, and enables the large holder to get over very many acres in a short space of time, and thus to accomplish it in the most suitable season, which is a matter of much importance. Mr. Pusey, urged on by the difficulty of getting a sufficiency of manual labour for the purpose of hand-hoeing, has still further extended the use of this implement by drawing it across the drills as well as between them, thus cutting out the turnips in small bunches, and employing children to single them afterwards. This gentleman states that he has effected a saving of nearly 7*s.* per acre by this plan, and where labourers are scarce and there is a good and regular plant the system is no doubt to be commended. On heavy land, where the ridges are not level, horse-hoeing is best accomplished by a single hoe, the principal feature of which is or should be for the first-hoeing a broad diamond-shaped tine, which does almost the whole of the work, the two other tines merely clearing away weeds from the vicinity of the plants;* but on lighter land an improvement is effected in the practice of hoeing turnips, by constructing the horse-hoe sufficiently broad to take three rows at a time, and yet light enough for one horse to draw. The horse as well as the man would of course walk in the middle row, which the writer suggests should be from 24 to 27 inches between the lines, whilst the two adjoining ones might be merely from 15 to 18 inches apart, an interval sufficiently wide for the hoe, though not for the horse to walk in. An additional horse can of course be attached if the labour is too great for one, or in case the land requires deeper stirring. The advantages of this plan would be that a large extent of land (at least 5 acres) could be got over by means of one horse and one man in the course of the day, and while the weather was favourable, and the operation of hoeing could be extended to a longer and later period.

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* Since the above was written, the ingenuity of our implement-makers has brought out several revolving horse-hoes, for the purpose of cutting out the roots into bunches, whilst the horse travels between the rows, the most successful of which, although the most expensive, is that introduced by Messrs. Garrett, of Saxmundham.

In Scotland and the north of England the custom is, to ridge up the land in intervals of 27 to 30 inches, under which the dung, if used, is placed, and the turnips drilled on the top of the ridge. The advantages in favour of the plan appear to be, that the land is more easily and effectually cleaned, the drilling more readily and better accomplished, and greater depth of soil afforded for the root. The objections to this method, and which are found to operate materially against it in the south and the east of England, are, firstly, that by ridging the land it is much more exposed to drought, and there is, consequently, greater difficulty in getting the seed to vegetate; secondly, a greater interval is required between the rows than is desirable for the sake of the crop; thirdly, that the plan involves more care and trouble, and extra labour in the last ridging up. These various objections are sufficient to forbid the practice to any extent in the southern and eastern counties, and even mangold-wurzel is now very generally put in on the flat, as it is termed. Three years since a friend of the writer's gave a fair trial to the practice of ridge and flat drilling, and although the former plan was by no means unsuccessful, as he was fortunate enough to get a good plant, yet the size of the roots did not compensate for their diminished number, and the ultimate weight was inferior to that realized on similar land put in on the flat, but with otherwise similar conditions. Nothing can be more clear than the necessity, in order that a plant should bulb well, that space should be afforded to it on every side. The widest interval at which Swedes and other turnips are drilled on the flat is 2 feet, and this interval readily admits two or three horse-hoeings, by which not only are the weeds destroyed, but the growth of roots is assisted by the ample stirring which the ground receives. In order, however, that there may be 100 roots to the rod, it will be necessary that the plants should be only 16 inches asunder, and, if 116 roots are required, the intervals must not be more than 13 inches. Now for several years past, in a rather extensive district, the heaviest swede crops have been obtained where there have been upwards of 100 and somewhat under 120 roots to the rod, and the intervals, in order to give this number with the ordinary hoeing, have not exceeded 21 inches, and in some instances been 18 inches only. This practice has been repeated again and again, and enables us to assert that, in order to obtain the greatest weight of swedes per acre, the distance of the drills should be as near as may be 21 inches, and the roots hoed out at intervals of 16 inches, which will give about 114 roots to the rod. This space will admit of several horse-hoeings, and is preferable to narrower intervals. Now, if we allow two roots per rod to fail and 112 to remain, it is easy to calculate the average weight per rod in order to give a certain weight per acre: thus at 3 lbs. each we have 24 tons, and, if the roots average 4 lbs. each, we have the splendid crop of 32 tons per acre, which in the South of England may be considered as the highest range of success. It should however not be forgotten that, if the land is unclean or infested with annual weeds, it is much better that the rows should be 2 feet asunder, in order that an extra horse-hoeing may be given.

Although the size of individual roots is no criterion as to the weight grown per acre, inasmuch as the roots are always largest where the crop is thinnest; yet there is a remarkable correspondence between the weight of particular roots and the goodness or badness of the crop generally. Thus we find at our Root shows, when the specimens of swedes, &c., are very large, the crop is good in the district in which they are grown, even though the selected roots may be taken from the thinnest portion of the crop. This fact, which we have noticed for several years, has not, that we are aware of, been pointed out by any other person, but it may be readily explained if we reflect that the same season which is favourable to a thick is also favourable to a thin crop, and thus, as each person brings his heaviest roots to a show, their size may be taken as a fair epitome of the goodness of the crop in the district, so that these exhibitions are not devoid of utility.

A few years since, when Peruvian guano was first generally introduced, many hundreds of acres of turnips were wholly or partially destroyed, in consequence of drilling with the seed two or three hundredweight of this manure, mixed with ashes by means of the ordinary drill. In common language, the seed was burnt by the strength of the manure, but probably the immediate cause was the carbonate of ammonia in the guano acting on the tender plant at the commencement of vegetation. The Ichaboe guano, less rich in ammonia, has been often drilled with impunity and advantage. In consequence of this peculiarity of Peruvian guano, the Royal Agricultural Society of England have mentioned, as one of the conditions for the prize turnip-drills, that means should be afforded so that a thin layer of earth may interpose between the seed and the manure. This was readily accomplished by making the manure pass into the earth somewhat in advance of the seed by means of separate tins, in some instances in the same track and in others somewhat at the side. Now, although this plan is necessary when Peruvian guano is applied by the drill, yet it is desirable with no other manure, but is in fact a positive disadvantage. Superphosphate of lime, though manufactured by means of so strong a caustic as sulphuric acid, is yet perfectly harmless as to its destructive effects on the young plant, and in fact the more closely it is drilled with the seed the better. The same observation also applies to other manures, so that when drills are constructed to allow the seed and the manure to pass by different channels, means should also be afforded to allow both to enter the ground together when so required. And, indeed, if the separate channels were dispensed with altogether it would be no great loss, as the guano could be applied broadcast, or if only 1 cwt. per acre is used with other manures, this quantity would not injure the seed if mixed a few days previously with an equal quantity of mould or earth. This, indeed, it may be observed, is a very desirable plan in all cases when guano is used even broadcast, as it prevents the finer particles from being carried away by the wind.* It is very desirable, too, that the coulters should be so constructed as to spread the manure in rather wide channels, and not in very narrow lines, as the feeding surface of the crop will be thereby increased. As respects the drop drill, I regret that I have not had the opportunity of testing its merits personally, and the reports from others are somewhat varied, but nothing in my opinion can be more correct than the principle on which it is founded.†

With regard to the liquid drill invented by Mr. Chandler, the most contradictory evidence can be adduced, both as to its advantages and disadvantages.‡ Not willing to trust to the opinion of others, in the year 1849 I made an experiment in order to test its merits. A small field of 3 acres was equally divided, and on the same day two drills entered the field, by means of which 3 cwt. of superphosphate of lime per acre were applied, in the one case with ashes and in the other with water. At the time of application, the middle of June, the weather was dry, and so continued for two or three weeks afterwards. The swedes came up where the liquid was applied, though by no means thickly, yet sufficient for a crop, but where the ashes were used scarcely one plant in twenty made its appearance. In the course of a month rain fell, and then a second vegetation took place, after the first lot had been hoed out; and this not only where the ashes but where the liquid also had been applied. This latter growth of roots, however, never came to any size. Up to this point my opinion was decidedly in favour of the water drill. When, however, the crop reached maturity the result was that where the dry manure was used the roots, though very thin, were in many instances of large size, but, where the water drill was employed, there was not a large root to be seen, not one above 5 or 6 lbs. in weight, although the crop was by no means so thick as to afford a reason for this diminished size. On the whole, there was more feed on the land where the manure was applied with ashes than on that manured by means of the liquid drill. I was constrained to draw this conclusion, that on land similar to my own, of rather a retentive character, this water drill was not favourable to the production of large roots and a heavy crop; and the result may be explained by the fact that a good seed bed is somewhat prevented by the rapid manner in which the seed is washed into the soil. On light land the results are more favourable than in the experiment I have related, there being a finer tilth for the water to act on. Unquestionably the season most favourable to the success of the water drill is neither the extreme of drought nor the contrary, for in the latter the water is unnecessary, and in the former it is not desirable to start the plant unless there is moisture enough in the soil to carry on vegetation. But in seasons rather inclined to be dry than otherwise, the additional water supplied by the drill is often of material assistance; and we may safely say that, with the water drill, there is a greater certainty of a plant. Although the distance from the source of supply must materially regulate the quantity, yet, if conveniently situated, the more water supplied the better, so long as the earth can at once absorb it, which is generally done if 5 or 6 hogsheads are not exceeded. On the whole, from our own experiments and those of others which we have witnessed in numerous instances, we are disposed to draw the following conclusions.:—

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* It has been urged with much plausibility that manures should always be applied broadcast, so that the small filaments that spread out from the root may be equally and abundantly supplied with manure. In opposition to this it may with truth be stated that, in the ordinary course of cultivation, the wheat crop which precedes the turnips has received a coat of dung, and that the land is therefore and ought to be sufficiently rich to furnish food for the lateral filaments, whilst the tap-roots and its numerous filaments can revel in the manure supplied in the drills.

† The practical objection that has attended the drop drill is the too crowded state of the bunches of plants that has followed its employment.

‡ This drill, invented by Mr. Chandler, acts on the principle of a mud machine, the manure and the water being put into a chamber from which it is raised by a number of small iron buckets attached to endless chains, the motion of which keeps the manure in a state of suspension. Each set of buckets deposit the contents into tins corresponding to the drills. The manure should be fine, and as soluble as possible; indeed it is particularly intended for the application of superphosphate of lime.

1st. That the liquid drill is more suitable for light than for heavy lands.

2nd. That it requires a finer tilth than the common drill, inasmuch as the ashes, &c., applied with the latter will fill up the insterstices in the soil and afford a fine seed-bed for the plant.

3rd. That it causes a quicker germination of the seed, and brings the plant somewhat sooner to the hoe (and consequently out of the way of the fly), than the ordinary drill, and also gives the plant a start of the weeds.*

4th. Although unnecessary when there is an abundance of rain, and undesirable when there is a drought, yet in many instances between these two extremes the crop may be saved by the use of the water-drill, when it would be utterly lost if the ordinary means were employed.

With regard to the quantity of seed, it is bad economy to be too sparing. It is quite true that half a pound of turnip seed would be quite sufficient for a crop; but when we consider the many enemies it has to encounter as soon as the plant gets above ground, and that the young plant grows better when tolerably thick, it is better to put 3 lbs. per acre, and more if we have any reason to doubt the goodness of the seed. Young seed vegetates more quickly than old, but swede seed two years old will grow very well, and it has this advantage that it admits of trial the previous year, and thus affords the opportunity of having its sort and quality tested.

With regard to mangold-wurzel there are various modes of sowing it. When dung is used it is better to plough the land in ridges, and so baulk up the land, dibbling the seed on the tops of the ridges above the dung, and a little artificial manure may be put in with the seed. It is now, however, becoming a frequent practice to drill this crop in the same manner as turnips, and the plan succeeds very well, particularly with the orange globe.

With reference to carrots we cannot do better than quote our friend, Mr. B., who has recently brought the subject before a farmer's club:—

> *Seed, and time of Sowing.*—The seed should be quite new, and the quantity required will be about 7 pounds per acre, which should be hand-rubbed and entirely free from burr; it may then be drilled by an ordinary turnip drill with the greatest regularity. The best time for sowing I have found to be the last week in April, or the first week in May, at which time in ordinary seasons the seed will vegetate immediately, which is essential in advancing the plant out of the way of the weeds, whereas in sowing earlier, as formerly about the 25th of March, the weeds grow and gain the ascendancy over the young plant

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* Since the above was written the attention of the writer has been more particularly bestowed on the water-drill, and the result has been that he has invented a drill on a totally different principle from that previously in use—its peculiar feature being that the water apparatus is distinct from that for the manure. The water is discharged by its gravity through pipes, and regulated and increased or diminished at the will of the drill-man, whilst the manure is delivered by certain tumblers, calculated to measure it out with mathematical accuracy in any proportions that may be required. The manure, whether consisting of bones, superphosphate or guano, either singly or combined together, may be used either with or without ashes, and with water or without it. It is therefore hoped that by this invention, the objections that have been hitherto urged against the use of the water-drill may be met and removed.

to such an extent as to endanger the crop in wet seasons, and at all times to greatly increase the cost of hoeing; a further advantage of late sowing will be found in the opportunity afforded for completing the tillage, and the destruction of weeds.

Drilling and Hoeing.—Upon shallow soils the land should be stitched into ridges 2 feet apart (drilling a single row on each side), for the purpose of giving a greater depth of soil for the plants to root in, and in extreme cases where land is unusually subject to weeds, it will allow of the free use of the horse-hoe. But upon all carrot soils well tilled, the best mode I have found is to drill upon the flat at 14 or 16 inches apart, for although the horse-hoe cannot so readily be used at this distance, because the weeds should be hoed out early, and before the plant is large enough to bear the horse hoe, yet the hand-hoe will be more effectual at the narrow distance, because the plants meet across the drills quickly, and permanently check the growth of weeds during the remainder of the season; whereas in the wide distance, although the horse-hoe may be continually employed, yet there will be sure to be a constant succession of weeds springing up, by reason of the carrot greens not being able to meet across the space until a late period in the season. The flat hoeing should be commenced between the rows as soon as the lines can be distinctly seen, and after the plants have attained the height of 5 or 6 inches, then use a 4-inch hand-hoe, and cut the plants out into little bunches 4 inches apart, then let women or boys follow, and single out the bunches, leaving the strongest plant; only one more hoeing will then be required if the season has been favourable; a few tall weeds may arise during the summer, which, with the plants that may have run up for seed, should be hand pulled. I estimate the cost of these operations as follow:—First hoeing 6*s.* per acre, singling 7*s.* ditto, last hoeing 5*s.* ditto, and weeding at 2*s.* per acre.

6*th. In what Cases Roots should be consumed on the Land, and when drawn off the Time of taking up and the Mode of Storing.*

It is certainly in the majority of cases the most profitable system to feed off the roots on the land, and not only is the custom most desirable in practice but it is also most consistent with scientific theory. A crop of 20 tons per acre cannot be carted off the land and put in stack for less than 20*s.*, and a similar amount will probably be incurred by carting back the dung to the land and spreading it. This sum of 40*s.* per acre will be more than sufficient to manure liberally an acre of land either for corn or roots, and there is in our opinion no sufficient advantage in the system of house feeding to compensate for the outlay, or rather the sinking of such a sum as this. Besides which there is no better mode of applying or distributing the manure than by means of the sheep themselves, particularly if the precaution is taken of shallow-ploughing or breast-ploughing the land, and so covering the manure with earth and preventing the escape of ammonia. Science tells us, and indeed proves, that the soil is the best fixer of ammonia. Thus it is that land on which sheep can feed without injuring it during the winter months is in greater request than any other kind, for it is undoubtedly the fact that 20 tons of roots on such land are worth (probably 25 per cent.) more, supposing them to be equally nutritious, than a similar weight of roots raised on land on which it is impossible to feed them off. The trials that have been made in the house feeding of sheep have been very contradictory. We have no reason whatever to doubt the evidence of those who have shown that their sheep have made more mutton from a given quantity of food, when fed under cover, than in the open air. Other trials have, however, been since made in which such a result does not appear to have followed, and it has been found that in many cases sheep will do better in the open air, particularly if they are young sheep, than when housed. Now it is a well ascertained fact that a certain quantity of food is used up in preserving the animal temperature, and that the colder the weather, the more heat is abstracted from the body, and the more food or fuel employed in restoring it. Therefore it appears quite in keeping with science that animals should thrive better when housed. It must, however, be borne in mind that the sheep is furnished with a thick and warm jacket, amply sufficient to keep the animal warm in the coldest weather. It is found also that in cold frosty weather sheep are generally healthy, and if they are well supplied with food do extremely well, whilst in wet weather it is just the reverse. During a glut of rain of several days continuance fat sheep will absolutely lose weight, however well supplied with food. Their woolly coats absorb a great deal of water, which is only removed by evaporation, in the process of which a very considerable amount of heat is abstracted from the body, besides that given off during the continuance of the rain, and thus it is that sheep do so badly in wet weather. It is therefore our decided opinion that the reason why sheep frequently thrive better when housed than in the open air, is not on account of the warmer temperature of the air, but because they are preserved from wet. And if this be the case it will account in great measure for the very contradictory reports that have been given of the effects of housing or fatting sheep, and explain that in a wet season the benefit of shelter is very decided, whilst in a dry season it cannot be seen.

If these ideas are correct they point very clearly to a modified system of housing, or rather of affording shelter in the field, and we cannot help thinking that the attention of our leading societies would be well directed to giving every encouragement to the erection of light moveable sheep-houses, capable of affording protection to a flock of sheep during wet weather, under which their food or a portion of it, such as hay or cake, could be preserved from injury. Now that iron can be purchased at a cheap rate, a light framing could, we imagine, be readily constructed and covered by canvas or other cheap material, and sufficiently light to be shifted, wholly or otherwise, from one field to another. This, we imagine, if it could be carried out would effect the *ne plus ultra* of sheep farming; such temporary buildings would also form excellent lambing houses, and during the summer the canvas cover might possibly be of great service in preserving hay and corn ricks from injury. There is a sort of calico manufactured which is well adapted for the purpose.

On heavy land it is often found that the treading of sheep during wet weather injures more than the manure benefits; therefore, unless on the same farm there is light land on which sheep can be kept in wet weather or during the middle of winter, reserving the heavy land for autumn and spring feeding, it is better to consume the roots in houses either by cattle or sheep.

Mangold-wurzel and carrots will of course be pulled, housed, and consumed under cover, although it is sometimes found that the former is very useful for sheep late in the spring, and carrots have been found extremely serviceable in the making out of fat lambs. A friend of the writer's has been very successful in this application of the carrot crop.

It is a very good custom where a portion of the roots are used for the fatting of cattle to pull about one-third and cart them off, leaving the remainder on the land to be fed off by sheep. By thus removing one-third or one-half the crop, corn or cake may be employed in feeding off the remainder, without that danger of throwing the future crops down by over-richness of the soil, which is often the case when the whole of a good root crop is fed off with the addition of artificial food.

The period for taking up and housing roots must depend very much on the state of the weather, and the maturity to which the roots have arrived. Both carrots and mangold-wurzel should be pulled up by the latter end of October, and swedes in the course of November.

With regard to the best mode of pulling them, this should be done by contract, care being taken that a sufficient number of hands are employed to keep the carts constantly going.

If the job is let to an experienced hand he will take care that the labour shall be of the most economical kind, and that each person shall be in the proper place.*

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* The following observations from Mr. H. Raynbird's "Prize Essay on Measure Work," contained in the seventh volume of the "Journal of the Royal Agricultural Society of England," on the subject of "Harvesting Root Crops," is worthy of attention, as supplying nearly all that we can wish for under this head. "The labourers, in doing this kind of work, may be paid by the acre; or when the crop is carried off the land, by the number of cart loads: the former method is to be preferred, as it affords a mode of measurement less liable to dispute. Men with large families are the best to engage in the taking up and storing away roots,

There are various methods of preserving swedes and other roots, and much difference of opinion as to which plan is the

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as their wives and children will be able to do a good portion of the labour. Harvesting roots is performed in various ways: I shall merely mention those plans most generally used. When the swedes are laid in small clamps of about 40 bushels on the land where they grow, the roots are pulled up and thrown into long heaps, the leaves being first cut or pulled off; the heaps are then covered, first with straw and then with earth. Seven shillings per acre will be a fair remuneration for the labour required in pulling and storing a good crop of swedes in this manner. Should the roots be both topped and tailed a higher price must be given. Another way of keeping swedes or white turnips is to cover the roots with the plough; the turnips are pulled and laid in a furrow opened by the ploughman, who, with another furrow, covers the roots with soil, leaving the tops above the surface. The cost of pulling and laying in the turnips will be about 3*s*. an acre, but it must of course be done by children, with a man as overlooker. Pulling, cutting off the tops, and filling turnips into carts, will cost about 8*s* per acre, but this must depend upon the size of the roots where the bulk of the crop is the same.

"*Harvesting Beet.*—The pulling and laying the roots in heaps ready to be carted away, the leaves being twisted off by the hand at the time of pulling (which is done by men, and is rather severe labour), is paid for at an average price of 5*s*. an acre; for a fair crop, at this rate, a man will earn 2*s*. a-day, for it will take about 2½ days to pull an acre. As the task-men pull the roots they are filled by boys and carried to the places where they are stored for the winter. With us the filling is done by day-work, at a cost of about 2*s*. an acre; four boys at 1*s*. a-day, filled 190 loads of 30 bushels off 7 acres of land in three days. The beet was pulled in the same time by six men at the rate of 6*s*. an acre. Banking beet, is the covering the heaps in which the roots are stored with mould, to keep out the frost; the heap is made about 4 or 5 feet in height, sloping like the roof of a house. A man will cover about 2 rods in length in a day; the rate per rod may be from 10*d*. to 12*d*. In a hard gravelly soil it took six men 3 days to earth up a heap 30 rods in length; at 1*s*. a rod they would have earned exactly their day wages, at 1*s*. 8*d*. a day.

"*Taking up and Storing Carrots.*—When carrots are sown broad-cast and the plants left thick the cost of taking up and cutting off the tops is sometimes as high as 18*s*. or 20*s*. per acre for a fair crop; but when drilled the cost for taking up is much reduced; this is caused by the carrots being handier to fork up when in rows; besides which they are generally singled out at greater intervals, and are consequently fewer in number and larger than those broad-cast We shall find that, if the work is done by day labourers, it will take six men to fork up an acre of drilled carrots: I know this to be about an average, from having assisted in this as well as in other kinds of works that I have described. It will take six boys or girls to cut the tops off as the carrots are taken up by the men. If we take the men at 1*s*. 8*d*. a day, and the children at 6*d*., we may calculate the cost of an acre will be 13*s*., and by piece-work it could be very well done for 12*s*. an acre. If the carrots are a thin plant the price will be proportionably lower, and if a very thick one it may be 2*s*. or 3*s*. above the sum I have stated. It must be borne in mind that this only includes taking up and topping."

In continuation of the subject of carrots we again quote our friend Mr. B.

"*Taking up and Storing.*—The usual time of taking up the crop is during the months of October and November, but in case of growing them to any considerable extent, it would answer the purpose to commence somewhat earlier, for although the root may be in a growing state, yet such is the value of the greens whilst in full growth, that a portion of the root might be sacrificed in order that a heavy crop of greens may be used for feeding at an earlier period. The lifting the crop should be performed with a strong three-grained prong, inserted at the side of the plant, pressing the plant obliquely with one hand, and pulling by the greens perpendicularly with the other. The mode of storing the roots must in a [illegible] measure depend upon the use to be made of them; when required for the best: some recommend putting them in rows of the width of a cart between hurdles and thatching them in; others think that they keep better if thrown in large or small heaps and covered with earth. Sometimes it is usual to top and tail them before this is done, but others contend that it is best to put them in whole. We are disposed to consider that they are less liable to rot when covered with earth, as the atmosphere may be more effectually excluded. One principal object in covering them up is to prevent their running to seed, which causes the root to lose much of its nutriment, and to become changed into woody fibre. This purpose can, however, be effectually accomplished where the swedes are intended to be fed off on the land where they were grown late in the season, by cutting them off at the crown and so removing both the stem and greens in the spring, by which means they may be preserved for months without injury.

7th. *The Effect of Cutting, Mashing, Cooking, and otherwise preparing Roots; in what Cases the Return will compensate for the Outlay.*

There can be no question as to the advantages and economy of cutting roots for both sheep and cattle. These animals are furnished with only one row of incisor, or cutting teeth; and however admirably these teeth are adapted for nipping off the grass, they are by no means so well constituted for dividing large roots, and indeed this cannot be done without a considerable expenditure of muscular power, which is equivalent to the expenditure of so much food.

Besides this, when turnips are fed off in the field without being cut, a considerable portion of the root is soiled and wasted, and particularly the rootlets and lower parts. The effect of leaving these fragments is injurious to the land, and tends to produce club root in the future turnip crop. When the turnips are cut up by a proper machine, such as Gardner's turnip cutter, the whole is consumed, no part is wasted, and the turnips are eaten by the animal with very little expenditure of labour, as the fragments are at once submitted to the molar teeth, which besides being much more powerful are placed nearer the centre of motion than the nippers, and thus can be more easily exercised. It is of course of much greater importance to cut swedes than white turnips for sheep, in conse-

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feeding of horses, cows, pigs, &c., they may be well kept by placing in a continuous heap, about 4 feet wide at bottom, carried up to a point, and thatched with straw, with a little covering of earth, leaving a small portion of thatch bare at the top to prevent heating; for although frost will not rot them like mangold or potatoes, yet they may lose a portion of their nutrition after being frozen; in case of being stored for sheep in open field they should be pitted in the same manner as swedes."

quence of their much greater solidity. Another advantage in cutting turnips for fatting sheep is that more time is afforded for eating oil-cake, or other concentrated food, as well as for rumination. Many persons prefer Gardner's turnip cutter, for cattle as well as sheep, as being less liable to produce choking than when the slices are broad and flat. With regard, however, to mashing and cooking roots, we believe that for either oxen or sheep there is no advantage whatever, the labour and fuel is entirely lost. Trials that have been made are altogether unfavourable. Mr. Walker, of Haddington, N.B., found five oxen and heifers on steamed turnips, &c., to cost 5*l.* 19*s.* more during the period of the experiment, than the same number on food uncooked. It is indeed agreeable to the constitution, and capacious stomachs, and powerful digestive organs of these animals, that roots should be consumed in a raw state.

There is only one animal, that is the pig, for which cooking is advantageous. This animal has only one stomach, which somewhat resembles that of man, and accordingly it is advantageous to prepare the food and so assist the digestive organs. Besides which, boiled roots are more palatable to the animal, and will be partaken to a much larger extent, than if raw, so that the pig may be partially fatted on them, and much meal saved. And as roots are cheaper than meal in proportion to the nourishment contained, there is a decided advantage in using them in combination. It is unnecessary, however, to boil roots for store pigs. Although boiled roots have not been found advantageous for fatting cattle, yet when milk is the object they have been found to answer the purpose of the cowkeeper, and to produce a larger quantity of this secretion.

8th. *The Quantities of Roots requisite to produce a given Weight of Meat; to what Extent Roots can be made to go further by the Addition of other kinds of Food, and in what Proportions. The effect of Warmth and Shelter on the economy of Food.*

It is somewhat difficult to obtain a satisfactory solution of the first question on this division of our subject; much will depend on the breed, age, and description of the animal fed, the warmth and shelter afforded, and somewhat on the nutritious character of the roots, which vary on different soils. It is stated by Mr. J. C. Morton, in his prize essay 'on increasing our supplies of animal food,' that it requires on the average 150 lbs. of turnips to produce 1 lb. of beef or mutton, which being reckoned at 6*d.* per lb. gives about 8*l.* 5*s.* as the feeding value of 20 tons. It is, however, usual to estimate them at a lower rate; in some cases not more than half this sum has been realized. The following table from Mr. Lawes' paper in the Journal of the Royal Agricultural Society of England, No. 29, page 188, will show the results of his experiments, and the quantity of food required to make a given quantity of mutton:—

	Average Food consumed to produce 100 lbs. Increase in Live Weight.			Average Food consumed per Head Weekly.			Average Food consumed per 100 lbs. Live Weight Weekly.			Average Gain in Weight per Head Weekly.	Average Gain in Weight per 100 lbs. Live Weight Weekly.
	Oil-cake.	Clover Chaff.	Swedes.	Oil-cake.	Clover Hay.	Swedes.	Oil-cake.	Clover Hay.	Swedes.		
	lbs.	lbs.	lbs.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Cotswold .	259¼	219	3608	8 1	6 14	113 4	5 4½	4 9¼	74 4	3 2½	2 2
Hampshire	294	259	3941	8 0	7 0	106 10	5 6	4 12¼	71 7	2 12	1 14
Sussex .	314	304	4086	6 3	5 14	79 1	5 6	5 2	68 14	2 1¼	1 10¼

It is impossible to keep animals of any description on turnips alone with profit, as the very large per centage of water contained in the root is injurious and requires some counteractive. In the case of young and growing animals, and any that are not actually fatting, this counteractive is found in hay, and sheep will do exceedingly well on turnips and good clover hay, indeed no cheaper diet can be given in proportion to the amount of nutriment obtained. Animals, it is true, have been fatted by this food, particularly in Scotland, where turnips are more nutritious. In the south of England, however, it is found that fatting cattle on hay and turnips is a very tedious process, and it is more advantageous to give in combination some portion of a more concentrated food, such as oil-cake, linseed, or grain. The principle on which the advantages of this system depend is the following. A considerable portion of the daily food consumed even by a fatting animal is expended in supplying the wear and tear, or waste of the system, therefore the longer an animal is kept the greater the aggregate amount of food thus expended. Now, in shortening the period of fatting by giving more nourishing food, we save the additional amount required to keep up the system during the longer period; and if this counterbalances the extra cost of the purchased food, we are considerable gainers by so doing; and even if it does not quite balance the cost, yet the increased quantity and quality of the dung will repay it. For instance, if animals can be fatted in half the time a double number can be fatted off, and a double quantity of manure made and of superior quality. Linseed or linseed cake is unquestionably the most nutritious and palatable food that can be given.

The former would certainly be so if it could be procured at the same cost as formerly, but as it is now about 3*l.* per ton dearer than cake it is not so profitable. It is quite a mistake to say that cake is merely the dross or refuse, as it contains upwards of one-third the oil, and all the albumen or flesh-making substance contained in the seed itself. In fact, good cake differs only from the seed in having had from one-half to two-thirds of the oil pressed out, leaving therefore a greater per centage of other nutritious matters. It can be used either coarsely crushed or made into mucilage, and poured over chaff or other food. Rape cake is almost equally nutritious, but much less palatable than linseed cake, but as it is considerably cheaper it is very desirable that if possible it should be used as food. Sheep will eat it if they have not tasted linseed cake, and it may also be given in combination with it. It has this advantage when given to sheep in the open field, that if a little should be wasted from the troughs it is not lost, as it is worth its cost as manure.

In giving linseed cake to fatting sheep or cattle, one point should be observed in order to make it profitable. We should begin early, and not give enough to displace very much of their ordinary food. Half a pound to a pound daily may be given to sheep, 6 or 8 lbs. to oxen; and although it is sometimes the case that a much larger quantity is given, we very much question the advantage of so doing unless towards the latter period of fatting. We know well that it will not pay to fat cattle on oil-cake and straw alone, even although the quality of the dung is much improved, because it will be necessary to give a very considerable quantity of cake; but if roots are given, a lesser quantity of cake will suffice, and the animal can take during the day a greater amount of actual nourishment than if roots alone are given even in unlimited quantities. The period of fatting is thus shortened, and this saving of time proves a recompence for the extra cost of food.

It will be convenient in this place to consider the relative feeding value of swedes as compared with linseed cake and other food, and this we propose to do by reference to the constituent elements of these articles and their relative value.

The following is the average composition of eight specimens of swedes, the calculation being made on 10,000 parts:—

Woody fibre	273·
Protein compounds containing nitrogen, 19·11 .	155 75
Sugar, gum, and starch	468·80
Pectic acid	36·37
Oil	27·94
Water	8,974·14
Ash, containing phosphate of lime, 13·41	
,, sulphur . . 4·5 .	64·
	10,000

The average of six specimens of linseed cake, in 10,000 parts, is as follows:—

Water	860
Oil	1,352
Protein compounds containing nitrogen 457, .	2,920
Starch, gum, sugar, and woody fibre . .	4,141
Ash	727
	10,000

Reducing these several calculations into tons, we find that one ton of good linseed cake is equal, as regards nitrogen, to 26¼ tons of swedes, as respects oil to 50 ditto, and sugar, gum, &c., to 7⅓ ditto; and we also find that as relates to nitrogen it is equal to 36½ tons of yellow turnips. Now, in placing a value on the different constituents of food, we have three divisions to consider.

1st. That which is usually represented by the nitrogen, being, however, 6¼ times the amount of nitrogen contained, and very similar in composition, whether in the form of gluten or albumen. This, in fact, nourishes the flesh or muscles of the body, and is most essential both as regards growth and strength. These protein compounds, as they are called by chemists, we have estimated as one-half higher in value than the starch, gum, &c., whose principal office is to supply food for respiration, and thus support the warmth of the body; the surplus, however, not thus required being converted into fat. The elements of combustion we have therefore valued at 1*d.* and the protein compounds at 1½*d.* per lb., which extra price we have placed on the oil, because, being ready formed, it is probably more quickly assimilated and more capable of producing fat than starch. Taking the above data as our guide, we have in a ton of linseed cake:—

	£.	*s.*	*d.*
764 lbs. of gum, starch, and sugar, at 1*d.* per lb.	3	3	8
650 lbs. of protein compounds, at 1½*d.* per lb. .	4	1	3
302 lbs. of oil, at 1½*d.* per lb. . . .	1	11	5
Total feeding value . .	8	16	4

We have of course placed no value on the 160 lbs. of ash, and the 364 lbs. of woody fibre.

In a ton of swedes we have:—

	s.	*d.*
94 lbs. of starch, sugar, &c., at 1*d.* per lb. .	7	10
24½ lbs. of protein compounds, at 1½*d.* per lb.	3	0¾
6 lbs. of oil or fat, at 1½*d.* per lb. . .	0	9
Total feeding value of a ton of swedes	11	7¾

If, therefore, the data we have pursued be correct, we find the feeding value of a ton of linseed cake to be equal to that of 15 tons of swedes, but inasmuch as the former is in a more convenient and portable form, and the theoretical value we estimated it at approaches very closely to the actual average cost, it will be necessary to reduce the value of the swedes some 20 per cent.; and if they are to be carted home, another 10 per cent., or 1*s.* per ton, must be subtracted to cover this expense. In combining cake and root feeding together, which is undoubtedly the most profitable and desirable method, we may consider that if we give sheep 1 lb. of cake per day each, they will either consume some 15 lbs. of swedes less, or eating nearly the same they will make more rapid progress.

The same rule obtains likewise with regard to cattle feeding, but with this modification; as the roots housed for cattle feeding have cost at least 1*s.* per ton more than if fed in the field, it is (supposing we are satisfied with the advantage of fatting cattle) still more desirable to use linseed cake for this purpose, which, in fact, is enhanced 15*s.* per ton by the expense of carting the roots.

It is hoped that these calculations, which we have worked out with some amount of labour, will be useful to those who have had no guide to assist them, save the experience of others, which experience has so differed in various localities, as to afford but a very confused direction to those who might wish to follow them. We have somewhat anticipated the subject of warmth and shelter, when speaking of the advantage of feeding roots on the land, but whatever question there may be as to the desirability of feeding sheep in houses, there is no question whatever as to the superior economy of affording warmth and shelter to cattle during the winter season. Besides the great saving of dung which is thereby effected there is also a great saving of food; for cattle, being but very moderately furnished with external covering, are more liable to be affected by cold and wet weather than sheep: they are, in fact, robbed by external cold of their animal heat, which it requires a large portion of food to keep up, and the same food would otherwise be employed in laying fat on the animal. Where straw is abundant there is no better method of fatting cattle than in boxes of 9 or 10 feet square, giving sufficient litter daily to preserve cleanliness, but allowing the litter to remain under the animal for several months, and so taking advantage of its weight to compress the dung into the smallest compass, and thus enable it to retain uninjured all its valuable constituents. It may not be out of place, however, to caution those who are about to adopt this plan against using cut straw or chaff for litter, the effect of which we have found in several instances to be highly injurious. It allows the feet of the animal to sink deep into the dung, and thus actually to stir it up and thereby causing fermentation of the mass, and great inconvenience to the animal from the heat engendered.

Where straw is scarce, or where the room is limited, stall feeding is most advisable, but even here the ground should be excavated a foot deep, and the space filled up with earth, which will fix the ammonia of the urine, economize the dung, and preserve the purity of the air. This plan should also be adopted with box feeding, and it will be found not only to economize the ammonia but to save a large quantity of straw.

We have said nothing relative to the various insects and diseases which turnips and other roots have to encounter, for to do justice to this subject would require an essay, and a long essay in itself. We must content ourselves by referring to the best works in which these subjects have been treated. Mr. John Curtis, F.L.S., is probably the best authority on the natural history of insects affecting the farmer, and he has very ably taken up these subjects in various articles contributed to the Journal of the Royal Agricultural Society of England. An account of the turnip-fly, the pest most familiar to agriculturists, as well as that of the black caterpillar, may be found in volume II. The ravages of the latter are confined to the turnip alone, whilst the fly will attack all plants whose four leaves or petals of the flowers form a cross, thence called Cruciferæ. These insects, it is well known, eat off the leaves of the young plant soon after they appear above ground, and they are much more rife before Midsummer and in May than afterwards, which has induced many farmers to delay the period for putting in swedes. They seldom attack turnips put in after vetches, but if mustard precedes vetches the fly is encouraged, as the following fact will show. In a field of five acres, in the occupation of the writer, a few years since about one acre was sown to white mustard early in the spring, which, though not very luxuriant, having been attacked by the insect, was fed off by sheep in May and sown with swede seed, with the rest of the field, which had remained a fallow. An excellent crop of roots was raised on the fallow, except on half an acre which adjoined that which had followed mustard. One-half the crop on this half acre was carried away by the fly, the ravages being greatest immediately adjoining the mustard acre, and gradually lessening, whilst the swedes planted after the mustard itself were entirely devoured, and had to be sown again.

The best preventive to the ravages of this pest consists in sowing plenty of seed, and forcing on the growth by means of superphosphate of lime, to which we may add the practice followed by some of sowing about 1 lb. of seed, broad-cast, with the object of obviating any accidental misses of the drill, while by affording food for the fly, which always attacks the unmanured and weakest plants, opportunity is given to the rows to get out of the way.

Wire-worms, which are treated by Mr. Curtis in the 5th volume of the Journal, do not confine their ravages to turnips but attack all roots, as well as corn and other vegetables. They are the offspring of beetles, of which there are nearly seventy species, although a few only (about eleven) attack farm crops. Lime, gas-lime, soot, nitrate of soda, Peruvian guano, sulphate of ammonia, and soda ash have all been recommended as top dressings to land infested with wire-worm, but probably the most successful application is to drill in rape cake with the seed. The rape cake, which is a good manure in itself, and which therefore under any circumstances will not be thrown away, should be broken up about the size of half inch bones, and applied with the drill. The worm feeds on the cake, and, it is said, is thereby destroyed. Heavy rollers, and particularly Crosskill's and Cambridge's, have been used with much advantage on land infested with wire-worm, the consolidation of the land thereby effected being unfavourable to the development of these pests of the farm.

In bringing our observations to a close it is hoped that, although, from the wide ramifications of the subject of discussion, they are necessarily curtailed and imperfect, they will yet in some degree assist and promote the extension of that important branch of farming which has justly been denominated the mainstay of British agriculture.

APPENDIX.

The Prize Essay to which this Appendix refers was written in 1853, and published in the following year—first in the *Journal of the Bath and West of England Agricultural Society*, and afterwards separately. Our object in this new edition is to make such addition as the experience of the last few years has brought under our notice, or rendered desirable; and, in so doing, we shall avail ourself of the same heading or divisions which the Council of the Society laid down for the observance of Competitors for the Essay itself. We may remark, however, at the outset, that the last few years have not enriched our knowledge of turnip cultivation to any great extent, and, indeed, throughout the greater portion of England, owing to the great drought which has prevailed during the Summer and Autumnal months, the growth of these roots has been rendered more precarious than previously, and the acreage weights less than in former years. We have little to add to the text under the first division of our programme.

1. "*The Kind of Land on which it is Profitable to grow Roots, with especial reference to any instances of Successful Management on Heavy Land.*"

Since our Essay was written, owing partly to the dry weather, partly to the too frequent repetition of the crops (thereby greatly increasing the enemies of the plant), and more particularly to the great prevalence of the disease called *aubury*, or *fingers and toes*, the growth of swedes and turnips has been rendered far more precarious than in previous years, and has, in consequence, been in very many instances supplanted by mangold wurtzel, which fortunately is not subject to such attack.

The disease we have alluded to does not exist on calcareous soils, but on gravels, sands, loams, and clays, in which lime is extremely deficient;

indeed, lime or chalk is the remedy in such cases, although it is useless to apply these materials if mangold, instead of swedes, is intended to be grown. Liming and chalking has been to a great extent discontinued of late years; and as the growth of turnips has increased, we can scarcely be surprised that the anbury should have increased likewise. When once the disease has appeared, however slight, it would be exceedingly undesirable to grow turnips or swedes until the acidity of the land has been neutralized by chalk or lime—mangold should be grown instead, until this is done, and this root is at all times more suitable for heavy land.

During the last few years the cultivation of mangold wurtzel has spread to a vast extent throughout the length and breadth of the land, so that where one acre used to be grown it is now by no means unfrequent to find ten. There formerly prevailed a prejudice against this root, arising partly from the supposed difficulty of getting the land ready for it sufficiently early, and partly from the idea that it was much less nutritious than swedes, and not adapted for feeding on the land, and also from the supposed impossibility of growing it without a dressing of dung. The first objection has been obviated by the practice of autumn cultivation, whereby little has remained to be done in the spring. It has also been ascertained, that whilst in some instances, and on some lands, it has been found less nutritive, in more numerous instances it has been found more so, so that we may, at any rate, consider it as at least equal; and analysis bears out this opinion. It can be grown on calcareous soils, but not of the same weight per acre as on loams and clays. Although, from its requiring more ammonia, and probably more carbonic acid through the medium of the soil than swedes, it yet can be, and has been, very successfully raised by artificial manures only. Although it contains much less phosphate of lime than turnips, yet the leaves contain twice as much as the bulbs, and being first formed, their development is much promoted by the application of phosphate, both soluble and insoluble. Its fondness for salt is readily explained by the analysis of its ashes, and its demand for ammoniacal applications is accounted for by the large amount of nourishment which it prepares for removal from the land. Whilst it will grow on calcareous land if there is a fair amount of surface soil, it yet requires no application of calcareous matter for its production on clays or gravels; and in soils of a peaty tendency, the application of chalk is positively injurious.

2. "*The Time, Mode, and Cost of Preparing Land for Roots, distinguishing between Light and Heavy Lands.*"

Although we have nothing to retract from the statements made in our text, yet it cannot be denied, that whilst the experience of the last few years has demonstrated the value and importance of Autumn cultivation, the inventive talent of our mechanists has brought the power to accomplish it far more within our grasp than was the case when our Essay was written. Without professing to decide between the rival systems of steam cultivation brought out by Mr. Fowler and Mr. Smith, it is well to observe, that during the past year the former has been awarded the prize of the Royal Agricultural Society, and the latter has received its medal. The former, the more expensive of the two, is specially devoted to the operation of ploughing, which he effectually accomplishes by means of a frame containing a set of ploughs, and drawn from one side of a field to the other by means of an eight-horse steam-engine, stationary when at work, but which turning a windlass, effects its purpose by means of a wire rope. No one who has witnessed the performance can doubt the success of the operation; and it but remains to show whether the economy of its working is sufficient to induce a large number of farmers to avail themselves of its aid.

Mr. Smith's is a lighter and less expensive affair, and is adapted to a peculiar mode of cultivation, in which the scarifier is largely brought into operation in the place of the plough, and, as is reported by Mr. Smith and his friends, with the greatest amount of success. The writer has witnessed the operation of both implements, and has every reason to speak favourably of their respective performances. Some erroneous ideas prevail as to the extent to which steam-ploughing, if successful, can be carried; but it must be borne in mind that a certain number of horses must be kept for the purpose of harvesting, manure carting, and carrying out the corn, and the *minimum* number kept for this purpose must be employed in tilling the land when not required for the above operations. By using lighter wagons, and by building the ricks still nearer the fields on which they were grown, a less number of horses will be sufficient for the work, so that probably about one-third the present number of horses will be dispensed with on farms where steam-ploughing can be rendered available.

3. *"In what Cases is it Profitable to Grow a Spring Crop of Green Food before Roots in the same Year?"*

We have little more to say under this head than to reiterate our former opinions, and to add to them the fact that the dry weather of the last few years has augmented their force. Those who, from inclination or necessity, have grown all, or nearly all, their root crops after tares or other green crops, have had far greater reason to deplore the uncertainty of their crops through the dry weather than others who have taken the advantage of a winter fallow; and more particularly those who having sufficiently cleared their land in the Autumn, have, by means of the scarifier, been enabled to dispense with the use of the plough in the spring, and thus to retain the natural moisture of the soil. It may be interesting to observe, that whilst the average rainfall for the month of June, in the locality of the writer for the last eleven years has been 2.18 inches; that for the last five years has been only 1 inch; and in 1858, was only 0.46, the driest June, in fact, for eleven years.

The following additional Meteorological observations noticed in this locality will also no doubt be interesting to our readers as closely appertaining to the turnip crop, and explaining in a measure its incongruities. The average rainfall for the last eleven years has been *yearly*, 26.28 in. and *monthly*, 2.19 in. ranging from 43.48 in 1852, and 39.74 in 1848, down to 17.18 in 1858, and 16.68 in 1854. The driest month has been February, which averages 1.35, the wettest October, which averages 3.65.

Again, for the turnip growing months of June, July, August, and September, the eleven years' average has been 9.08 inches, whilst for the last five years it has been only 6.47, and for the previous six years it was 11.25. Can we wonder, then, that the turnip crop should have been deficient of late years?

4. " *The Quantities, Sorts, Time, and Mode of applying Manure to Root-Crops with especial regard to Economy.*

Under this head we have nothing to alter in the statements made in our text, but extended experience has demonstrated their correctness. This is particularly the case with regard to the success of those guanos rich in phosphate of lime. We have always considered that the phosphates of lime in these guanos have not been sufficiently appreciated by chemists, and that the peculiar condition and the fine state of division they are in after having passed through the intestines of birds, render them more easily taken up by plants, and sufficiently explains their success. Many experiments on the application of manures during the last few years have been instituted and published—some with satisfactory, others with very anomalous results. Dr. Voelcker has taken considerable pains during two or three seasons to institute some very useful experiments, but, unfortunately, the very dry weather experienced at Cirencester, has greatly disturbed the conclusions that might otherwise have been derived from them; indeed, in various instances a superior manure (by analysis) produced very moderate results; and, on the other hand, a very inferior manure produced a crop nearly equal to the former—for example, 3 cwt. of a manure containing less than 4 per cent. of the phosphates, 1 per cent. of ammonia, and nothing else of any value, produced 8 tons 14 cwt. of swedes, whilst the same quantity of another very costly manure, containing 53 per cent. of phosphates, 23 of which were soluble, produced only 8 tons 9 cwt., and 3 cwt. of Peruvian guano only 8 tons 18 cwt. of swedes. Such anomalous results, while they are insufficient to establish the superiority [illegible] one manure over another, point strongly to a truth which agriculturists would do well to ponder over, and the non observance or indifference to which has led indirectly, but not with less certainty, to more adulteration and fraud in artificial manures than all other causes put together—viz. that on land in high condition a weak manure will often produce as great a result as a more powerful one, and more particularly if from the absence of rain, or other favourable contingencies, the crop only reaches one-half the amount it would otherwise have attained. This result has, in numerous instances, induced purchasers to select manures containing not more than one-half the valuable qualities of other genuine articles, and purchased perhaps at some few shillings less cost per ton. We have ourselves known, during the past year, many similar instances of such result. Agriculturists forget, that by purchasing a ton of a genuine superphosphate they can, themselves, with the assistance of a ton of fine earth or ashes, produce two tons of a manure superior to many of these vaunted articles, and at nearly half the price. We repeat it advisedly, that whenever an agriculturist purchase a quantity of such inferior compounds without ascertaining its quality by analysis, he inflicts a three-fold injury—he injures himself by the difference between the value of the article and its actual cost; he injures the fair dealer or manufacturer, who would otherwise supply him with a genuine manure at a fair price; and he injures the whole agricultural community by the encouragement thus given to imposition.

Experiments in other districts, during the last season, have tended to the corroboration of these conclusions, though not to so striking a degree. They are, however, sufficiently interesting and important as to deserve special notice. Thus, in some careful experiments conducted by Mr. Coleman, at Holkham, in Norfolk, we find, that in one trial instituted for the purpose of ascertaining the best quantity of superphosphate to apply per acre, that whilst 1 cwt. of superphosphate produced 8 tons 16½ cwt. the natural unaided produce of the soil being 6 tons 3 cwt., 10 cwt. of the same only gave 14 tons; and whilst 3 cwt. produced 1 ton of roots more than 2 cwt., 7 cwt. of superphosphate produced only 1 cwt. more than six.

Again, in another experiment with different manures, but in which the weights are stated as well as the analysis of the manures, we find that one containing about 5 per cent. soluble and 19 insoluble produced as much as another containing 21 soluble and 6 insoluble, the ammonia being about the same. We also find in another batch of experiments, where as much as 6 cwt. of superphosphate was used, that one manufacturer's, containing about 12 per cent. soluble and 9 insoluble, was superior to another possessing no less than 23 per cent. soluble and 7 insoluble, the ammonia being nearly the same; so that 72lbs. of soluble and 54lbs. insoluble exceeded, in this instance, 156lbs. soluble and 42lbs. insoluble. Of course such results can only be accounted for by reference to certain unknown accidental circumstances attending each plot, in addition to the fact that the crop being a moderate one the weaker manure supplied as much food as the crop could consume.

We observe in these analyses the singular fact, that a so-called wool manure contains only 10½ per cent. of organic matter and 1⅓ of ammonia, the analysis of wool being 98 per cent. of organic matter and 21.4 of ammonia; and a blood manure has 1.62 of ammonia, whilst blood itself contains nearly 19 per cent. of ammonia when deprived of its water; so that the manure could not have contained more than 10 per cent. of dry blood even if all its nitrogen was derived from this source, which is scarcely possible. Would it not be much fairer if both these manures were called by their proper names, viz., Superphosphate of Lime, which, really, in these instances, is somewhat illused, being called upon to do all the work yet receiving none of the praise.

While the tendency of Dr. Voelcker's experiments is decidedly in favour of superphosphates over Peruvian guano, in Scotland the latter manure has been long the favourite, and it was not till its price became excessive that superphosphate was enabled to disturb its almost undivided sway. Many trials have been made, some of which seem to furnish evidence in favour of the former, and others in favour of the latter. It should be borne in mind, however, that as Peruvian guano demands a considerably greater amount of moisture than superphosphate, so the wetter climate of the north is more suitable for it, and, indeed, we may consider it as a fact that in Scotland more ammonia is required for root crops than in the south. Thus, in some careful experiments, instituted by Mr. Grant, in 1858, a manure containing only 16lbs. of soluble phosphate, 100 of insoluble, and 25lbs. of ammonia per acre, produced nearly 15 tons of turnips; whilst another, containing no less than 90lbs. soluble, 37 insoluble, and 9lbs. of ammonia, produced less than 12 tons per acre. The same result occurred in several similar experiments, affording a very good proof of that which has been considerably doubted of late years, viz., that a certain quantity of ammonia is of value to root crops, for as the more productive manure contained less of the phosphates altogether, therefore the difference must have been owing to the ammonia, unless the increased, or nearly double per centage of organic matter, which the more productive manure contained, is the cause. It has been satisfactorily proved that organic matter, when conveyed to plants in the form of rape cake, is of essential service to the root crops, though not to the same extent as phosphate of lime, and we fear that the custom of many chemists in their valuation of all organic matters in manures at 20s. per ton, is somewhat loose, for if we take it that in the form of rape cake, it is three or four times the value as if found in sawdust. We have before expressed a strong opinion that the value which has been assigned to bone phosphate, viz., at 3s. 4d. per lb. or £7 per ton, though given on high authority, is founded on incorrect data and is therefore erroneous and calculated to mislead, inasmuch as it necessitates the putting of a fictitious or too high value on the soluble phosphates.

This observation will be very clearly shown during the present year, for we believe that superphosphates, whether sold under their old or real name, or an assumed designation, will from most good makers contain a greater proportion of soluble phosphate than hitherto, although they will be rendered at a somewhat reduced price. Now some of the experiments we have mentioned would certainly appear to throw considerable doubt on the benefit of this increased solubility, were it not for the fact that farmers have a remedy in their own hands by using a portion of bone dust in the room of some of the superphosphate that might otherwise be applied. Thus, although by the aid of improved management, and a larger supply of phosphates and cleaner materials, a more soluble superphosphate is manufactured and thus becomes commercially more valuable, yet considering the price at which it is sold it will show the folly of making such a vast disproportion between the value assigned to bone phosphate and soluble phosphate respectively.

Now bone dust does not cost the farmer less than £8 per ton delivered into his neighbourhood, and this might be considered to contain on an average, phosphate of lime 52 per cent., organic matter 32 per cent., ammonia 4½ per cent. Thus, in reckoning 100 tons we have

52 tons of phosphate of lime at £10 -	£520
32 tons of organic matter at £1 - -	32
4½ tons of ammonia at £50 - - -	225
Moisture alkaline salts, &c. - - -	22
	£800

Bone Ash is about the same value, and supposing it to be of a very superior quality, 100 tons of it would contain 80 tons of phosphate of lime, which at £10 would amount to £800.

It will be seen above, that we have estimated the ammonia in bones at only £50 per ton, which we have done in consequence of the crude state in which it is in and the decomposition required in order to render it available, and the longer period required before its full benefit is elicited. In the form of commercial superphosphate we consider that the ammonia is more valuable, equal in fact to that contained in Peruvian guano, say 6d. per lb. or £56 per ton, the reason being that the organic matter which contains the ammonia is reduced to a state which renders its ammonia more readily given up. By a parity of reasoning we consider the phosphates in guano also more valuable than in bones, being in a much finer state of division and having been passed through the bodies of birds, and thus becoming digested. This, and the fact that some portion of the phosphates are in a soluble state, alone explains the very excellent results which nearly always follow the employment of Saldanha Bay, Bolivian, and other phosphatic guanos, and which, in many instances, have fully equalled the effects of an equal quantity of Peruvian guano. These guanos are considered to be always the deposits of birds, in regions affected by rain, which is supposed to have washed out nearly all the ammonia. This is not, however, invariably the case, for we have found, on examining many hundred tons of Saldanha Bay guano (which variety, however, has now been pretty well exhausted), the skeletons of a great number of seals, but in no single instance the remains of a bird. We should, certainly, in the case of Peruvian and other guanos, be disposed to place a somewhat higher value on the phosphates contained, and a somewhat less value on the ammonia.

We should be inclined to place a somewhat higher value on the ammonia in sulphate of ammonia, in consequence of its being extremely soluble and yet fixed by sulphuric acid so as to secure it from evaporation; but, of course, in this case, we put little or no value on the sulphuric acid, the presence of which being a necessity.

These observations may be made with still stronger force with reference to nitrate of soda, which, if judiciously applied, has, undoubtedly a special value, greater than its amount of nitrogen, or nitric acid would denote, inasmuch as a greater effect can be produced by a very small application, if wisely applied as a top dressing, in which manner alone it should be used, than by an equal value of Peruvian guano. If, however, either of these manures are used as *under*-dressing, and long before their virtues are required to be available, then the very solubility which renders them more valuable in the one case, causes them to be of less value in the other.

On land deficient in calcareous matters, and consequently liable to club root, if swedes or turnips are grown, which is scarcely to be recommended, although a very small portion of superphosphate may be desirable to force the plant into rough leaf, the remainder of the phosphates had better be given in the form of bones or guano, or both combined.

5. "*The best Mode of Cleaning the Crop, the distance between the Plants, and the most useful Implements for Sowing and Cleaning.*"

We have little to add under this head. The revolving horse hoe, a very ingenious implement for thinning out the plants, has not come into general use, which may in some measure be due to the fact that, from the dry weather that has prevailed for some years past during the turnip season, and the consequent greater exposure of the crop to the ravages of the fly, it has been deemed more prudent to trust to manual labour which secures the preservation of the strongest plants.

The same absence of rain, by diminishing the supply of water, has often rendered the water drill impracticable; and in other districts it has been shown that the use of water, when the land is in the [illegible] dust, is by no means favourable, as from the limited area [illegible] which the water can extend, although the seed may malt, yet vitality is often cut off when the rootlet enters the dry earth beyond the range of the water. The season most favourable to the water drill is undoubtedly that in which there is a moderate amount of rain, so that the vegetation of the seed, induced by the water, should be kept up by the surrounding moisture.

In our essay we expressed an opinion that, whilst it was always desirable to prevent the contact of Peruvian guano with the seed, it was rather advantageous than otherwise that superphosphate should be in close proximity. The observations and experiments of after years have rather induced us to modify the latter observations, for although practically speaking, if the superphosphate is diffused amongst a fair amount of earth or ashes there is little or no danger, yet if the season is dry and the quantity of ashes inconsiderable, there is danger of many of the plants being destroyed. In making some experiment with seeds in 1855 and 1856, we have found that turnip seed will vegetate far better in pure water than where a very small quantity of superphosphate has been dissolved; and if the latter is a little increased, vegetation ceases to take place. Dr. Voelcker has also ascertained that this is the case, and with sulphate of ammonia in a still greater degree.

With regard to the distance between the drills, we have nothing to add with reference to turnips; but we have a strong opinion that mangold wurtzel should have ample space for the development of the leaves. The minimum space should be two feet if drilled alone, but if a row of carrots are drilled between them a less distance is sufficient, as the following experiment will show: – In the year 1856, and the month of May, an acre of mangold wurtzel was drilled 18 inches apart; and the same day, on the adjoining land, mangold and carrots were drilled alternately by the same drill, set for the same number of rows, or rather for two rows of carrots and three rows of mangold, the outside rows being the latter. The manure was the same, viz., 4 cwt. per acre specially prepared, no dung being used. The result was that the acre of mangold was 26 tons, whilst the adjoining acre produced 28 tons and 12 tons of carrots besides. In the latter instance the roots were much larger, which we attributed to the rows being three feet apart, the carrots between having no injurious effect.

6. "*In what cases Roots should be Consumed on the Land and when drawn off, the Time of Taking up, and the Mode of Storing.*"

We have little more to do than to endorse our previous remarks under this head, to which, however, we would add a custom that is sometimes adopted on light lands, particularly after a mild winter when a premature disposition is evinced to run to seed, that is, the practice of covering up the roots and stopping vegetation by ploughing the land, and afterwards feeding off the roots in dry weather on the ploughed land. This is a very economical mode of attaining the desired object, but is of course only applicable to dry land.

It will be useful to our readers here to quote from a recent number of the *Agricultural Gazette* some excellent and practical remarks, signed " J. M.," and coming, if we mistake not, from a pen in every respect qualified to speak with authority on the matter:—

" The mode of harvesting our root crops, which we have adopted for several years, is this: we let the lifting of the roots, the cutting off the leaves and the roots, putting the bulbs into the cart, and afterwards to put the leaves into the cart, at so much per acre to one man, who gets other men to join with him in the work and to share in the profits; and the arrangement I require to be adopted is, that the one-horse carts employed to haul the bulbs shall be constantly employed, and they require from 16 to 18 tons of roots to be filled hourly. The number of carts required is according to the distance of the field to the store; thus, if the distance from the middle of the field to the store be 15 chains, four carts are required; if 22 chains, five carts will be required; and 30 chains require seven carts.

" *The Mode of Lifting the Roots.*—Five men are employed to pull up the roots; each man takes two rows; standing between them he takes with his left hand a root from the row on his left side, and with his right hand a root from the row on his right side, and pulling both up at the same time, places them side by side across the row where he pulled up the roots with his right hand, so as to have the tops lying in the space between the two rows he has pulled up; the next man takes the two rows at the right hand of the last two rows we have just described, and he with each of his hands pulls up roots and places them on the line of the row which he has pulled up with his left hand, with the root end lying towards the root end of the first row, so that we have now four rows of roots lying close together in two rows side by side, with their leaves on the outside of each of these rows, and the roots of each row nearly touching each other; and every four rows when growing are thus, when pulled, laid in two rows root to root, occupying not more than 27 inches. Now as the next four rows are lifted in the same way, and placed in like manner, we have a space unoccupied of three times 27 inches or 6 feet 9 inches between each double row of roots for the cart to go between them to carry off the bulbs. After the five men pulling the roots there follow women or boys with knives, made of pieces of old scythes, who by repeated blows cut off the leaves and roots without moving one of them with their hands. This is constant work, and it requires 10 active women to keep up with the five men pulling.

" Immediately on the heels of the cutters follow the carts between the two double rows of bulbs as they lie, having their leaves and roots cut off, and one of the contractors and nine active boys and girls throw up the bulbs as far as they can into the cart, the man speaking to the horse to move forward or stop, as they clear the ground. When one cart is full an empty one has been brought by one of the boys who drive the carts, and placed immediately behind the full one; so that as the boy moves off with the full cart the man calls the horse with the empty cart to move forward, and they proceed to throw the roots into the cart as fast as they did into the one that is just gone off the field.

"The pulling of the roots and the filling of the carts being the principal work, one of the contractors is in each of these departments, and the work proceeds with the utmost regularity and despatch; 20 cart-loads have been filled hourly in the field and delivered in the store; 182 loads of a ton weight each have been pulled, in a day of nine hours, by 6 men, 10 women, and 9 boys and girls.

"The stores are made of posts and rails inclosing a space 9 feet apart, 4½ feet high, and of any length the space will admit, and as near to where they are to be consumed as possible. The posts are 5 feet apart, let into the ground 18 inches, with five rails 5 inches wide nailed to the inside of the posts; and each of these stores is 3 feet apart. I have 14 of these 70 feet long, which is sufficient to store from 1000 to 1200 tons of bulbs.

"In placing the roots in the store we put straw inside the rails of some thickness, to keep out the frost and wet from the side. As the store is being filled, the end of the store being railed off as the sides are, straw is placed against it and against the sides for 8 or 10 feet from the end; the carts are backed to the end, the tail-board of the cart being taken out, the load is tipped and the horse walks out of the store, when a boy who by this time has brought another loaded cart, walks off with the empty one to the field; two stores are being filled at the same time, so that each gets the alternate loads. There is one man who places the straw and thatches the stores as they are filled, one man to back the carts and empty them in the store, and two men, two boys, and two women throwing up the roots level with the other rails, and raising them in the middle, so as to form them into such an angle as will do for thatching.—*J. M.*

7. "*The Effect of Cutting, Washing, Cooking, and otherwise Preparing Roots.*"

We only refer to this head to observe that whatever doubt might have been entertained as to the advantages or disadvantages of cooking or boiling roots, these have been, since our essay was written, set aside by the undoubted superiority and economy of pulping, both for beasts and pigs, and which the many excellent pulping machines lately introduced, have afforded the ready means of accomplishing. Instead of adding to the quantity of its water, which boiling or steaming does; by pulping the water is materially lessened by evaporation, which the large exposed surfaces enables to be effected; and not only so, but the fine state of division to which the roots are reduced, suits admirably with the increasing practice of mixing linseed meal and corn meal with the pulped roots. Several friends of the writer have adopted the practice of using linseed cake, ground into meal and mixed with roots, both for beasts and sheep, and they report most favourably of the practice. The meal prevents any injury from the coldness of the roots, and the oil in the former being more largely diffused than if the cake is consumed alone, it is less likely to pass through the bowels in an unchanged and consequently valueless state.

8. "*The Quantities of Roots requisite to Produce a given Weight of Meat; to what extent Roots can be made to go further by the addition of other kinds of Food, and in what proportions. The Effect of Warmth and Shelter on the Economy of Food.*"

In our Essay we have endeavoured to compare the relative value of roots and cake; but whilst it is very easy to make the comparison in respect either to the flesh or heat producing elements alone, it is very difficult so to apportion the relative value of each element as to be able to make a correct summary of the whole. We have estimated the starch, sugar, &c., as 1, and the protein compounds,* as well as the fat, as 1½. Mr. Lawes considers the fat as 2½ times as valuable as the starch or gum. We think this, however, is going rather too far; for it should be borne in mind that it is now well ascertained that animals (the pig to wit) have the power of readily converting gum and sugar and starch into fat; besides which, a considerable portion of the former elements are essential to keep up the warmth of the system. In order to ascertain correctly this interesting point, in which the physiology of animals forms a strong feature, it is desirable that a system of experiments should be carried on with food of the same character, but differing only in the amount of oil contained, *e.g.*, between linseed and linseed cake, which would be more satistactory than between linseed cake and cotton cake. It is much to be regretted that the Smithfield Cattle Club does not devote some portion of its ample funds to the purpose of carrying out such experiments on the feeding of cattle. If, with a given amount of other food, two lots of animals were fed, one with linseed crushed and the other with linseed cake, we should be able to ascertain the relative value to be placed on the oil.

It should be observed, that since our Essay was written the consumption of linseed cake has considerably increased, and its price has advanced some 10 to 20 per cent. We do not think we have overestimated the value we have assigned to the protein compounds or albumen; for, although it is very true that only a small part of the albumen, or nitrogenous portion of the food appears in the increase of the flesh of the fattening animal, the greater portion being found in the excrement, yet we must bear in mind that when an animal is put on food rich in nitrogenous matter, such as linseed cake, the greater part of the nitrogen is found in the urine, and not in the dung, which shows that it has been digested and assimilated, or taken up into the body, thus affording, as it were, the system an opportunity of converting into flesh as much as the constitution of the animal is capable of accomplishing. We must also bear in mind that whilst fat remains in a quiescent or dormant and unchanged state, so long as an animal is supplied with sufficient food to keep up the animal heat, flesh, on the other hand, is subject to constant wear and tear; some portion is perpetually being used up and rendered unfit for the purposes of life. We must not, therefore, imagine that all the nitrogen of the food not present in the increased flesh is consequently wasted, for very much is required to keep up the status of the animal, and much of the nitrogen in the excrements proceeds from the used up tissues of the body.

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* Those elements in food containing nitrogen, and which nourish flesh, are called by chemists protein compounds. Albumen, gluten, caseine, [illegible]latine, all come under this head.

Again, we must also bear in mind that even if the protein compounds are valued so high as 2d per lb , they are worth two-thirds of this value as manure; and if we were to suppose it possible—which of course is not the case—that the whole could be converted into flesh, then 2d in the form of food would become 40d. in the form of flesh (at 8d per lb.), for we must not forget that 1 lb. of albumen represents 5 lbs. of flesh.

Thus, although the estimated value of the different elements of food may be considered as correct, if the only purpose in view is to preserve life and keep up the animal system without either increase or exertion, yet, when the object is either on the one hand to fatten, or on the other to obtain an expenditure of animal force, we are then justified in attaching greater importance, and consequent value in the one instance to the fat, and in the other to the albumen. We should, therefore, be disposed to estimate the value of the oil and the albumen at 2d. per lb., and to retain that of the starch and sugar at 1d. Estimated in this way we have the value of a ton of good cake, as follows:—

	£	s.	d.
764 lbs. of gum, sugar, and starch, at 1d. per lb.	3	3	8
650 lbs. of flesh-making compounds, at 2d. ditto	5	8	0
302 lbs. of oil, at 2d. ditto	2	10	4
	£11	2	0

This is about the present value of the best linseed cake. The ash would, perhaps, make it amount to a few shillings more, which may be placed against the expense of breaking it up. If the above is a correct approximation to truth, which is all that can be hoped for on such a problematical subject, it will be very easy to add or to deduct a per centage, so as to make it accord with the current value of the article.

In our Essay we have given the average analysis of the swede turnip, as well as of linseed cake; with the idea of extending our usefulness, we will now add the analyses of other feeding stuffs, which we can most conveniently do in the form of a table:—

	Beans.	Peas.	Wheat.	Barley.	Oats.	Maize.	Locust Beans.	Rape Cake.	Linseed Cake.	Linseed.	Mangold.	Swedes.	Turnips.	Carrots.
Albumen and other Flesh making Elements	24·	23·4	12·7	13·	13·6	11·1	3·3	29	27·3	20·5	1·8	1·5	1·2	1·5
Starch, Gum, and Sugar	46·	48·	57·	56·5	46·5	64·5	50·7	23·1	27·4	20·5	11·1	4·7	4·5	11·5
Oil or Fat..	2·	2·	·9	·3	5·	8·	0·3	11·4	11·9	34·		·3	0·2	
Vegetable Fibre	10·	10·	12·4	13·7	20·8	5·2	22·3	17·1	14·	10·5		3·8	3·1	
Ash	3·4	2·5	2·4	3·3	3·3	1·1	1·	8·	6·	4·5	1·	·7	.7	·8
Moisture	14·6	14·	14·6	13·2	10·8	10·1	22·4	11.4	13·4	10·	86·1	89·	90·3	86·2
	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·	100·

N.B.—For the sake of simplicity we have avoided giving more than one decimal in this table, minute accuracy not being required. The analyses of roots must be taken with some reservation, as the roots of different soils vary considerably in their amount of nutriment.

As the pests of the turnip crop have considerably increased during the last few years, probably owing to the very dry weather which has prevailed, we cannot do better in this Appendix than supply the omissions in our Essay by quoting from the best authority on the subject, Mr. Curtis. We may observe, however, with respect to the fly, that during the last year an implement has been brought out by Mr. Rowley, called the blast drill, the object of which is to dust both surfaces of the young plant by blowing some powder on the leaf, thus injuring the fly to a certain extent, and protecting the leaf from its ravages. During the coming season the efficiency of this implement will no doubt be fully tested. Amongst the substances desirable to apply we should be disposed to recommend a little guano mixed with soot or fine ashes. Mr. Curtis gives us the following summary with regard to the turnip fly :—

" There are at least two species of turnip-flies or beetles, the ***striped*** and the ***brassy***.

" The habits of the latter are not known.

" The *eggs* of the former (*altica nemorum*) are laid upon the under side of the rough leaf, from April to September : they hatch in ten days.

" The *maggots* live between the two skins or cuticles of the rough leaf, and arrive at maturity in sixteen days.

" The *chrysalis* is buried just beneath the surface of the earth, where it remains about a fortnight.

" The *beetles* live through the winter in a torpid state, and revive in the spring, when they destroy the two first leaves, called the cotyledons, or seed leaves.

" There are five or six ***broods*** in a season.

" These insects are most to be feared in fine seasons.

" Heavy rains, cold springs, and long droughts, destroy them.

" Their scent is very perfect : the beetles fly against the wind, and are attracted from a distance.

" To extirpate them during the first three stages is apparently most difficult.

" The beetles are sheltered in hedges, banks, under bark of trees, &c.

" Their *parasites* have not yet been discovered.

" *First appearance* of the beetles to be punctually observed, as affording the best chance in applying remedies.

" ***Manure*** to render soil obnoxious to the insects scarcely to be expected.

" ***Rapid growth*** of the plant the best security :

" To secure which *sow plenty of seed*, and of the same age.

" ***Burning*** beneficial, by destroying the chrysalides.

" *Sheep-folding* must destroy the insects in every state.

" *Deep ploughing* excellent when the chrysalides are in the soil.

" *Drilling* far superior to broad cast, and believed in Scotland to keep away the beetles.

"Dangerous to sow on a *stubble-crop*; and *long raw manure* harbours the beetles.

"*Lime and soot*, the benefit derived from them in this way very doubtful.

"*Mangold wurtzel* not favourable to the beetles; and *swedes* probably less attractive than white turnips.

"Mixing white turnips with swedes not desirable, as the beetles may be attracted by the strong scent of the former.

"*Early sowing* attended with disadvantages.

"*Destroy charlock*, and all cruciferous weeds in fields and hedges, as they afford support to the beetles before the turnips come up.

"*Hoeing and rolling* harass and destroy the beetles.

"*Watering the crops*, especially with weak brine, beneficial.

"*Paul-net* and *painted boards* useful in destroying the beetles.

"*Fumigation* by burning stubble, &c., will keep off the beetles.

"There are many other remedies proposed, some of which it might be well worth trying; and if we be defeated in our endeavours to vanquish this insect enemy, we must take the field again with fresh vigour until our efforts are crowned with success, and neither despair from disappointments, nor rest in listless security from the apparent inertness of our foes. If we look back for one instant to experience, we shall find that after violent attacks of disease in the animal, or of blights in the vegetable kingdoms, they are generally succeeded by a respite of many years, which throws us so much off our guard, that when they return we are not prepared with any proper remedies, and not unfrequently they are altogether forgotten; thus after a lengthened interval of tranquility, when we think the hordes of hostile insects have departed for ever, they suddenly make their appearance, and take us by surprise and at advantage. The intelligent farmer must therefore be up and stirring, to detect the first breath of infection, and be instantly prepared with his remedy."

Although the ravages of the *black jack* (the caterpillar of the turnip *saw-fly*) is not so frequent, nor, on the whole, so destructive as *the* "fly," yet, from its often assailing and destroying a crop that had resisted its previous enemies, and on which great expenses had been incurred, its attacks often become still more annoying. We cannot, therefore, do better than again quote the summary of Mr. Curtis's able paper on the subject, from the second volume of the "Journal of the R.A.S.":—

"The *turnip saw-fly* is called by scientific men *Athalia spinarum*, and also *Tenthredo centifoliæ*. These flies *come over* from the north of Europe, but are probably bred in small numbers annually in England.

"It is *eighty-five years* since their first appearance was recorded.

"Their *mischievous visits* are at extremely irregular intervals.

"In 1782 many thousands of acres were entirely destroyed in the county of Norfolk by the black caterpillar.

"*Subsequently* to 1782, the year 1835 has proved the most fatal to the turnip-crops from their attacks, the produce of a second and third sowing being destroyed by the black caterpillars.

"In *July*, *August*, and *September*, the saw-flies are most abundant; but they have been found as early as the 29th of March, and as late as the middle of October.

"The *male saw-flies* are the smallest, and hatch first: they are supposed to be most abundant, but my experience leads to an opposite conclusion.

"On being touched they *feign death;* and are torpid in moist and cloudy weather, but very active in the sunshine.

"They *rest* by night on plants and flowers, and *feed* upon the pollen.

"They seem to *fly* against the wind, like the turnip-beetles.

"*Watering* the plants as soon as the saw-fies appear would in all probability preserve the crop.

"Scattering finely-powdered *salt* over the turnips when they are wet would keep the females from depositing their eggs.

"The *eggs* are laid immediately after pairing, between the cuticles of the leaf, close to the margin, or in the edge of a large hole, and are deposited singly in cells.

"Outside *rough leaves* are selected for this purpose; and the leaflets at the base are often preferred.

"The turnip saw-flies *live* twelve or fourteen days, and the females are exceedingly tenacious of life.

"A female will lay from 250 to 300 eggs; and they hatch in from five to eleven days.

"The *black caterpillars* are about one-tenth of an inch long at first, but three-quarters, and sometimes nearly an inch in length when arrived at maturity.

"They *change their skins* thrice during their lives, which extend to nineteen days, or three weeks.

"*Previous* to changing their first skin they have the power of emitting a thread from their mouths and are difficult to shake off: after the first moult they fall down on the slightest touch, and lie curled up.

"If the *caterpillars* be disturbed whilst *moulting* they die.

"They *descend* into the earth and there form a cocoon, in which they change to pupæ, often lying in the ground the whole winter; but in summer the saw-flies hatch in three weeks.

"When they descend into the *earth,* if it be *fresh and moist,* it is better suited to their economy than when it is very dry.

"*Light soils* seem to suit them best.

"*Swedes* by the side of white turnips often not touched; in other instances they have suffered equally.

"*Swedes* more or less infested, but not a caterpillar to be seen on the English turnips.

"The *young larvæ* are *fastidious;* and when feeding on an old leaf do not relish a young one.

"They are most *voracious* immediately after changing their skins; and when nearly full-grown do the most mischief.

"They do not appear *simultaneously;* and there are often three broods in a year.

" A *thunder-storm* destroyed myriads of the black caterpillars.

" *Cold* checks their progress, and often kills them ; and *wet* causes diarrhœa, which carries off great numbers.

" Checked and destroyed in the ground by the *frost* of January, 1838.

" Sometimes attack fields in *patches;* at others, commence on one side, going regularly forward; and again leaving, perhaps, a space in the middle and all the borders untouched.

"*Large* and *open fields* more liable to be attacked than small and enclosed ones.

" *Rooks and swallows* are very serviceable in thinning their ranks, the former feeding on the caterpillars, the latter upon the saw-flies.

" The caterpillars seem to be nearly free from *parasitic enemies.*

" The *strewing of quick-lime,* coal-ashes, and soot has been attended with various successes, and generally with beneficial results.

" Repeated *rolling* has killed and checked the caterpillars ; but its effects are partial.

" *Hoeing* an attacked crop the most fatal experiment, until all the caterpillars have disappeared.

" Drawing a *cart-rope* over the turnips to shake off the caterpillars has proved more or less effective, most so when a brush made of elder-boughs has been fastened to it.

" An *axletree* with wheels, the former armed with *green furze,* drawn along the rows, wounds and destroys the larvæ, as will also a *bushed hurdle*

" *Brushing* the larvæ off with *live twigs* and stamping upon them, a man following with a *scuffler,* has cleared a field of the larvæ.

" A *trench* judiciously cut will often preserve a portion of a field, or an adjoining one.

"*Hand-picking,* when the larvæ are not excessively abundant, may be depended upon as a certain remedy ; and when in great numbers they may be brushed into sieves.

" *Pigs* will destroy the black caterpillars.

" *Ducks and poultry* will devour them with avidity; and this seems to be the most easy and effectual method of extirpating the black caterpillars : the birds may either be carried or driven into the field, according to the distance.

" Sheep driven over fields infested with the caterpillar have done essential service."

N.B.—Since the above was in press Mr. F. Hobbs has brought the subject of the turnip fly before the R. A. S. E. and has stated that he has found the following powders of essential service in preventing the ravages of the pest: 1 bushel of gas lime, 1 bushel of common lime, 6 lbs. of powdered sulphur, and 10 lbs. of soot; this is sufficient for 2 acres and should be applied when the dew is on the ground.